# Illuminating Engineer

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Official Journal of
THE ILLUMINATING ENGINEERING SOCIETY
FOUNDED IN LONDON 1909
INCORPORATED 1930

# The ILLUMINATING ENGINEER

THE JOURNAL OF GOOD LIGHTING

*Edited by*

J. STEWART DOW

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# "All The World's a Stage . . ."

TWENTY-FIVE years ago Mr. J. B. Fagan reminded members of The Illuminating Engineering Society that "The Play's the Thing."

Mr. L. G. Applebee, in his Cavalcade of Stage Lighting (see pp. 69-82), echoes this sentiment. He describes and illustrates many elaborate devices for the illumination of the stage—and there is available to-day a wealth of equipment for stage lighting undreamed of by the great actors of the past. But he points out that lighting, however achieved, must be subservient to the main motive of the play.

Is it not true, in this respect as in others, that "all the world's a stage"? Of all modes of lighting, stage lighting, in its infancy, approached nearest to the principles we endorse to-day. "Light on the object, not in the eye," was the method of the footlights. In endeavouring to solve any lighting problem we should ask ourselves, "What purpose does the lighting serve?" In almost all cases good lighting is unobtrusive. We only become aware of its existence when we realise the perfect visibility of our surroundings.


## *Standardisation*

A very able address on the above subject was given to the London and Southern Junior Gas Association on January 25 by Mr. S. F. Dunkley, who drew attention to the vast variety of plant equipment, apparatus and materials handled by the gas industry. After explaining the nature of standardisation and the benefits of united effort on the part of industries, Mr. Dunkley surveyed efforts at national standardisation in various countries and such measures towards international standardisation as exist. Very impressive was the tabular presentation of the activities of the thirteen main sections of the British Standards Institution. It may come as a surprise to some of our readers that the section on illumination alone furnishes work for fourteen technical committees and thirteen sub-committees, though the operations of some other sections (the mechanical, for example, with forty-nine technical committees and 125 sub-committees) are on a much bigger scale.

## *Flashing Signs and Broadcasting*

In connection with a paper on Broadcast Interference and the Power Engineer, read by Mr. J. Neale (General Post Office) before the London Local Group of the Electrical Power Engineer's Association on January 21, an interesting demonstration of broadcasting interference from the illuminating flash sign was given. A rotating flash switch was put in operation. Every time a contact was made a distinct "plot" was heard emanating from the loud speaker connected on a receiving set—the conditions being arranged to simulate those arising when a listening set is in the vicinity of a flashing sign. In view of the increasing numbers of neon signs now being erected the possibility of interference is, the author suggested, a matter worth serious consideration. Incidentally, it was mentioned that only the red neon signs, operated on 50 cycle A.C. voltages of the order of 2,000-15,000, are found to cause interference. The most effective remedy in suppressing the interference is the insertion of a special choke coil in series with the neon tubes. Precautions are necessary, in making tests of neon signs for interference, owing to the high voltages used and the possibility of shock. An arrangement has now been made with leading neon sign manufacturers and maintenance firms that tests may be carried out on signs under their control by a specially trained Post Office staff.

## *Lighting in a Village Community*

We are indebted to Mr. S. B. Langlands and Mr. E. J. Stewart for the following amusing example of primitive public lighting conditions, which is extracted from the "Aberdeen Weekly Journal."

After fifty-three years' existence, it is stated, the Town Council of the village of Tarland has ceased. It had a Provost, four baillies, treasurer, five councillors, and a town clerk, but acted without statutory powers. It was simply a body of public spirited residents. At the annual election the names of candidates on slips of paper were distributed to the women in the village at their homes. The men voted in Cromar Hall, and on the evening of the polling day the sealed envelopes in which the voting slips were placed were opened in the presence of the local policeman, and some of the oldest residents. The Town Council came into being when a movement was set on foot to light the village. The Council at that time consisted of twenty members, and contributions from the Town Council, together with donations from the late Lord Aberdeen and Tarland residents, gave to Tarland its lighting system of twenty-one paraffin lamps. The Council went out of existence on December 31, and at midnight on Hogmanay the Council's lamplighter took the lamps from the streets and locked them up in a shed. The funds to carry on the management of the Cromar Hall, the care of the War Memorial, the maintenance of the lighting system, and the control of a dump for the refuse, were got from the proceeds of dramatic entertainments and other social functions and from voluntary subscriptions. A Hall Management Committee has been formed. It is considering the restoration of the lighting system.

## *Three-Colour Traffic Lights in Paris*

There has been some divergence of opinion as to the merits of the intermediate "yellow" traffic signal usual in this country. Until recently, Paris, for example, utilised only two colours, red and green, but apparently warning of an imminent change in colour was given by a bell. Now, it is stated, the three-colour system, familiar in Great Britain, is to be adopted.

# TECHNICAL SECTION

COMPRISING

Transactions of The Illuminating Engineering Society and Special Articles

*The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.*

# The Illuminating Engineering Society

## Notes on Recent Meetings & Events

### Meeting in London, February 19.

A MEETING of the Illuminating Engineering Society took place in the Lecture Theatre of the Institution of Mechanical Engineers (Storey's Gate, Westminster, S.W.1) on Tuesday, February 19. Members assembled for light refreshments at 6.30 p.m. In the unavoidable absence of the President (Mr. H. Hepworth Thompson), the chair was taken by Mr. A. Cunnington (Vice-President) at 7.0 p.m.

The minutes of the last meeting having been taken as read, the Hon. Secretary read out the names of applicants for membership, which is appended. The names of those presented at the last meeting on January 8* were read again, and these gentlemen were formally declared members of the Society.

The Chairman then called upon Mr. J. M. Waldram and Mr. J. M. Sandford to present their paper on "The Time Characteristics of Tungsten Filament Lamps for Signs, Signals, and Beacons." The paper was read by Mr. J. M. Sandford, whilst Mr. J. M. Waldram conducted the numerous ingenious experiments and demonstrations by which it was accompanied.

In the subsequent discussion, Mr. C. C. Paterson, Col. C. H. Silvester Evans, Col. J. P. G. Wooledge, Mr. G. H. Wilson, Mr. G. Winch, Mr. A. Blok, Mr. J. S. Dow took part. After Mr. J. M. Waldram had replied to comments, a cordial vote of thanks to the authors of the paper terminated the proceedings.

* Illum. Eng., Feb., 1935, p. 33.

### Forthcoming Events.

**March 12.** Mr. H. N. GREEN on **Recent Developments in the Lighting of Airways and Aerodromes** (*Joint Meeting of the Illuminating Engineering Society and the Royal Aeronautical Society, to be held at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1*); **6.30 p.m.**

### Applicants for Membership.

SUSTAINING MEMBER:—

The Lighting Trades, Ltd., 51-55, Garratt Lane, Wandsworth, London, S.W.18.

*Representative*: Mr. A. E. Fry.

CORPORATE MEMBERS:—

Barnicot, J. M. .....89-91, Newman Street, LONDON, W.1.

Batchelor, E. L. .....5, Bloomsbury Square, LONDON, W.C.1.

Evans, E. S. .....South Metropolitan Gas Co., 709, Old Kent Road, LONDON, S.E.15.

Matthews, F. G. .....Gas Works, Chertsey, SURREY.

Smith, Geo. .....“Sanyon,” 26, Tumblewood Road, Banstead, SURREY.

Stedrick, E. .....South Metropolitan Gas Company, 709, Old Kent Road, LONDON, S.E.15.

Williams, H. R. S. ...Gas Works, Altrincham, CHESHIRE.

Windibank, T. H. ...16, St. Helens Road, Norbury, LONDON, S.W.

COUNTRY MEMBERS:—

Bridgewood, L. .....Boyle Hall, Nr. WAKEFIELD.

Clifford, C. W. C. ...49, Hagley Road, Edgbaston, BIRMINGHAM.

Koppel, A. A. .....C/o Hotel Trachtenberg, 4, Urkvel Israel, Tel-Aviv, PALESTINE.

Mollan, J. H. .....29, Shepherds Lane, Harehills, LEEDS.

AFFILIATED STUDENTS:—

Canning, J. C. .....69, Bankside, LONDON, S.E.

Cole, C. R. .....21, Calvert Road, East Greenwich, LONDON, S.E.

Griffiths, W. F. .....188, Poplar Road, Merton Park, LONDON, S.W.

Hartwell, R. .....Penn Vicarage, Nr. WOLVERHAMPTON.

Wilen, J. A. .....57, Finchley Road, Hendon, LONDON, N.W.

***(The paper by Mr. J. M. Waldram and Mr. J. M. Sandford and the ensuing discussion will appear in our next issue.)***

# Illuminating Engineering Society

(Founded in London, 1909 ; Incorporated 1930).

# Election of Officers and Council Session 1935-1936

## OFFICIAL NOTICE

IN accordance with the procedure specified in the Articles of the Society, a list of existing Officers and Members of Council, of vacancies occurring and of duly qualified persons nominated by the Council for vacancies about to occur in the offices of President, Vice-Presidents, Hon. Treasurer, Hon. Secretary, and Ordinary Members of Council, is presented below for the information of the Members of the Society.

In the event of any Members desiring to put forward other names, the Council will be pleased to receive such nominations, which should be made in accordance with the following rule (Article 48) :—

> "After the issue of the Council's list, and not later than the 15*th day of April* next following, any ten Members (but no more than ten) may nominate any other duly qualified person to fill any such vacancy by delivering such nominations in writing to the Hon. Secretary, together with the written consent of such person to accept office if elected, but each such nominator shall be debarred from nominating any other person for the same office at such election."

### Present Officers and Members of Council

***President*** :—*Mr. H. Hepworth Thompson*

***Past Presidents*** :

Mr. A. P. Trotter, M.INST.C.E.
Sir John Herbert Parsons, C.B.E., F.R.S.
Mr. D. R. Wilson, C.B.E.
Mr. C. C. Paterson, O.B.E., M.I.E.E.
Dr. J. W. T. Walsh, M.A., D.SC., M.I.E.E.
Lt.-Col. K. Edgcumbe, T.D., M.INST.C.E., M.I.E.E.
Sir Francis Goodenough, C.B.E.
Lt.-Com. Haydn T. Harrison, M.I.E.E., R.N.V.R.
Mr. C. W. Sully.

***Vice-Presidents*** :—

*Mr. A. W. Beuttell* (1932)
Mr. A. Cunnington (1933)
Mr. S. B. Langlands (1934)

***Members of Council*** :—

Mr. W. A. Bishop (1934)
Mr. H. Buckley (1934)
Mr. J. G. Clark (1934)
Mr. A. C. Cramb (1933)
*Mr. R. S. Downe* (1932)
*Col. C. H. Silvester Evans* (1932)
Miss C. Haslett (1933)
Mr. George Herbert (1934)
*Mr. C. Hughes* (1932)
Mr. A. E. Iliffe (1933)
*Mr. W. J. Jones* (1932)
*Mr. Stephen Lacey* (1933)
Mr. Waldo Maitland (1934)
*Mr. C. A. Masterman* (1932)
Mr. A. B. Read (1934)
Mr. T. E. Ritchie (1933)
Mr. James Sellars (1934)
Mr. Ernest Stroud (1933)
Mr. G. H. Wilson (1933)

***Hon. Secretary***: *Mr. J. Stewart Dow* (1928)

***Hon. Treasurer*** :—*Mr. Percy Good* (1933)

### Nominated by the Council to fill Vacancies

***President*** :—Mr. A. W. Beuttell, M.I.E.E.

***Vice-President*** :—Dr. S. English

***Members of Council*** :—

Mr. D. Chandler
Dr. W. M. Hampton
Mr. H. Lingard
Mr. F. W. Purse
Mr. W. R. Rawlings
Mr. F. C. Smith

***Hon. Secretary*** :—Mr. J. Stewart Dow

***Hon. Treasurer*** :—Mr. Percy Good

The names in italics are those of retiring Officers or Members. The date in parentheses after each name indicates the date of election to Office or Membership of the Council.

# A Cavalcade of Stage Lighting

By L. G. APPLEBEE

*Paper read at the meeting of the Illuminating Engineering Society, held at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1, at 6.30 p.m. on Tuesday, January 8th, 1935.*

I must confess that, when preparing this paper on "Stage Lighting," I was greatly tempted to ignore the past and to commence at the year 1934, but for the benefit of those who have little previous knowledge of the subject, I feel that a brief (to use a Noel Coward term) "Cavalcade" of Stage Lighting will not only be of interest, but the correct method of approach to the modern methods.

## *Early History*

Allardyce Nichol, in "The Development of the Theatre," tells us that the Greek Theatre at Athens is the ancestor of all the theatres of Modern Europe; and that Greece was not only the first European country practising Dramatic Art, but that the forms and conventions of the classic playhouses were carried down through the theatres of The Roman Empire, The Middle Ages, Renascence, Italy, and thence over to this country through the Elizabethan and Restoration periods to modern times.

Nichol also tells us that the first indication of lighting was in the fifth century B.C. in the Dramas of Aeschylus, Sophocles, and Euripides. The fact that these performances commenced either before the dawn or just before sunset led to time references in the dialogue. These early Greek dramatists used the lighting of King Sol to assist the atmosphere of the play, as the only scenery was the natural countryside.

It was not until after 465 B.C. that any backing or scenic wall was erected behind the actors, and many hours might be spent in describing the developments of the Stage Proscenium, etc.; but as this paper is entitled "Lighting," I must leave this very interesting section. I may, however, just pause to mention that in 458 B.C. the first revolving stage was used. It was known as a Pinax, and seems to have been a triangular prism, on each side of which was painted a certain scene or symbol, placed on a central pivot which could be revolved in order to display a change of scene. One of these was known as a Lightning machine, the three sides being coloured black and across each being painted a lightning flash.

At about the same time a "Semicircle" was introduced. It stood upon the "Orchestra" and gave a view of a far distant landscape, a description which suggests the first cyclorama.

In 55 B.C. the first Roman theatre was constructed under the direction of Pompey, and about 25 B.C came the introduction of a curtain which, unlike modern methods, dropped into a hollow recess placed towards the front of the Stage.

It is not until the Renascence period, 1425 to 1498, that any data in regard to Stage Lighting can be found. By this time Stage "machines" had been introduced, and spectacular effects such as thunder and lightning were being studied, whilst, we are told, squibs and fireworks were used to give local colour to devils.

To light, too, the Renascence artists paid due attention, and they realised that many of their effects must depend on the judicious placing of candles and oil lamps. Leone Hebroe de' Sommi, a theatre writer of the time, counselled that lights should be placed in the streets upon the house roofs and towers in comedy, giving the effect of gaiety with the first view of the scene, and that the lights should be diminished when the first unhappy situation occurred. There seems to have been considerable diversity of opinion in regard to the placing of these lights. Some contended that they should be overhead, whilst Nicola Sabbatini, who published his treatise on "Scenes and Machines" in 1628, suggested that a parapet should be placed towards the front of the stage, and that lights be placed behind it. These were called "floatlights," because they consisted of open flame oil lamps, in which the wick floated in animal or vegetable oil. This explains why in some theatres footlights are still called "floats."

Selastiano Serlios, in 1551, gave directions concerning the use of coloured lights by the use of bottles filled, country-chemist-wise, with red and blue liquid, the candles or lamps being placed in immediate proximity to them.

In Elizabethan theatres, in 1576, we find little mention of stage lighting, although Dyce, in his "Life of Shakespeare," tells us that public theatres at the time of Shakespeare's tenure of the "Globe," had "two ample branches of a form similar to those now hung in churches, to give light to the stage."

## *Experiments at Drury Lane*

Mr. J. B. Fagan, in his paper read before this Society in 1919, tells us he can find no further trace of stage lighting until 1663, when Sir Christopher Wren built the first Theatre Royal, Drury Lane, and Inigo Jones contrived the stage mechanism. A glass roof was built to the theatre, but proved inadequate as a lighting unit, and the stage was lighted by two or more hanging coronas containing about thirty candles to each. Nichol tells us that in Daniel's play, "The Queen's Wake" (1610), Jones accomplished an elaborate change of scene by moving lights which dazzled the eyes of the spectators, and which, we may presume, was the first use of what we know to-day as "blinders." David Garrick introduced footlights at the second Drury Lane Theatre in 1755, together with lights up each side of the proscenium arch and in the wings, although he retained the corona on the stage, and they appeared in every scene, whether an interior or exterior. They were not concealed behind the borders until Sheridan managed Drury Lane, in 1784.

At this time tallow candles had replaced the open flame oil lamps. Fuchs, the American writer on stage lighting, tells us that it was a frequent occurrence for an attendant known as a snuff boy to slip out in the middle of some scene and attend to smoking candles. Towards the end of the eighteenth century the development of the Argand burner for oil, with its glass chimney, superseded the candles. These chimneys provided the first step to the use of colour, as they could be stained, and at the first Haymarket Theatre, by an ingenious system of levers, the coloured glasses were made to sink over the white light, and thus produced moonlight effects.

## *Gas Lighting at the Lyceum*

In 1803 the original Madame Tussaud was occupying the Lyceum Theatre, then known as the English Opera House, with her original waxworks, and she vacated the theatre in this year, in order that Mr. Winser might make the experiment of lighting the place with gas. This was twenty-two years after its invention by the

Scotsman, Murdock. Its installation was at first regarded as dangerous, but it proved extremely successful, and Henry Irving, at the Lyceum, and Sir Augustus Harris, at Drury Lane, commenced in this country the first really successful attempt at realism by the aid of light. For the first time its intensity had been harnessed, and the dimming the light made possible the blending effects. It is largely due to their efforts that the value of stage lighting came to be realised in this country.

The control of the intensity of the light was effected by means of valves. The "gas plate," as the regulator was termed in those days, was the forerunner of the dimmer regulator of to-day. Irving obtained many of his coloured effects by fitting revolving colours made of silk around each burner of the footlights and sidelights, and completely covered each batten—much in the same way as the revolving colour batten which has just been placed on the market in this country, except that to-day the movement is by means of an electric motor.

## The Limelight

Fifteen years after Murdock invented gas, Henry Drummond invented the limelight, but it did not find favour in the theatre until 1860. It was produced by burning a mixture of hydrogen and oxygen and causing the flame to impinge upon a block of lime. The introduction of a lens in front of the piece of lime provided the first spotlight. Although the electric arc and the projector electric lamp have replaced this form of illuminant, many theatre folk still refer to spotlights as "limes." Some may be surprised to know that the gas mantle (1890) owes its conception to the limelight. The incandescent gas mantle made its advent too late to be of use in the majority of theatres where electric light had already superseded gas. Therefore, the bulk of the gas lighting of those days was done by open flame with flash burners and glass chimneys, needless to say, the heat on the stage was terrific and the actors were subjected to a perfect Turkish bath!

It would, however, be difficult to say which of these two light sources was the more important. It is safe to state that both revolutionised the stage and made the portrayal of realism a possibility.

In the early days of the limelight the two gases were contained in rubber bags, on which the operator often used to sit in order to obtain sufficient pressure, but the explosion of one of these with tragic results to the operator, caused the authorities to order the use of steel cylinders, and ultimately theatres installed tanks with pipe feeds to the various points. As a spotlight it is the ideal, because the source of light concentrates the light in the centre of the beam, dying off to a soft edge, whilst the result is mellow and soft. It is still used for some effects; for example, the Theatre Royal, Drury Lane, used it in their last production, "The Three Sisters."

It is rather singular that limelights should have had such a long spell of popularity, seeing that Sir Humphrey Davy exhibited his electric arc in 1808—a date, however, long before electric generators had been devoloped. Dubosq, in 1846, used the arc to represent the rising sun at the Paris Opera and later produced a rainbow by passing the light through a glass prism, a method still employed in Germany to this day.

## The Coming of Electric Light

The first record I can find of the arc in an English theatre is in John Hollingshead's "History of the Old Gaiety Theatre, 1868-1903." This arc was not used for stage work, but is worthy of mention. It is stated that at the opening of the Old Gaiety Theatre, in 1868, a "flash lamp" was installed on the roof with the largest voltaic battery then obtainable, and that it played upon the church of St. Mary-le-Strand and Charing Cross terminus. Its use was discontinued before it frightened the horses and caused damage to life and property. Jablochkoff's candle was produced in 1876, and in 1879 the Bellecour Theatre, at Lyons, was equipped with this device, but the early advent of the incandescent electric lamp rendered it obsolete.

Swan, in England, and Edison, in America, produced their respective incandescent electric lamps in 1879, and in 1881 the Paris Opera House was converted for the use of this type of illuminant. The first English theatre to instal this system was the Savoy, also in 1881. So sceptical were those behind the enterprise that the whole house was equipped with gas as well. This, of course, now sounds rather humorous, but some people even to-day, fifty-three years after, are still nervous, and only just recently, owing to the "Grid" eccentricities, a large theatre in the West of England has made provision for a temporary gas footlight. The fact that by resistances the intensity could be raised and lowered much in the same way as gas, whilst the lamps could be lacquered any desired colour, was a step forward, and the comparatively small heat of the electric globe, about one-fifth that of the gas jets, was a great relief to the actors.

The Lyceum was the last London theatre to go over to electric light, in 1902, mainly due to the late Ellen Terry's wish, who was of the opinion that electric light revealed the scenery in all its marked trashiness. This view was also strongly held by the late Henry Emden, the scenic artist, who maintained that the heat rising from the gas created an atmosphere and gave the scene life, whilst under electric light the scene looked hard and cold. The arc spotlight and flood soon commenced to replace the lime. The enormous use of these spots can be realised when I mention that Sir Herbert Tree used as many as forty in one scene. As each single one required an attendant, the labour costs can be imagined.

When in 1907 the metal filament lamp made its appearance, the same objection as was expressed by Ellen Terry was again raised. Producers complained that it was "cold," and many ordered the lamps to be tinted a very pale amber.

The principle of lighting in this country from 1895 until after the war practically remained the same. The continent, however, had been moving steadily towards improvements, mainly due to the scenic design of Ellen Terry's son, Gordon Craig. Digby, in the discussion of Fagan's paper, told us that in 1902 the lighting in continental theatres was not flexible, and generally at rather a low ebb compared with that in this country, and Craig was regarded as a dreamer and his methods as eccentric. However, his production of Hamlet at the Moscow Art Theatre and his exhibition of scene designs, impracticable as they appeared, stimulated stage reform all over Europe, and such men as Fortuny, Appia, Rheinhart, etc., commenced to work mainly along the lines originated by him.

## The First Cyclorama

In 1900 Mariano Fortuny began in Germany an extensive series of experiments. The system was installed at the Scala Opera House in Italy in 1902, and was the first attempt to produce scenic effects by the use of light only. The first cyclorama, which consisted of a curved cloth, which enveloped the whole of the stage, was installed. It was constructed of a double dome of silk which worked like the hood of a perambulator, and when opened out was the shape of a quarter orange, the silk being kept free from wrinkles by being made double, the space in between being exhaused of air.

The lighting units, which consisted of arc lanterns projected their white light on to coloured silks which reflected their coloured light on to the cyclorama. The effect caused a sensation. Under the lighting the cyclorama silk cloth appeared to entirely disappear and produced the illusion that the spectator was really looking out into infinite space, while the mixing of the colours by varying intensity gave any de

sired effect, just as an artist mixes colours in his palette. Apparently the only theatre in this country to experiment with this system was the Birmingham Repertory Theatre. The large space required and the expense of running have militated against its adoption in this country. On the continent, however, it created a new method of scene construction. The great State Opera Houses of Germany, Austria, and Italy, commenced to use cycloramas, although their systems of lighting varied.

The Charlottenburg State Opera House, built in 1912, has a similar spherical cyclorama of plaster carried on a girder above the fly rail, and can be moved up and down stage. In the Schauspielhaus, Dresden, completed in 1916, the cyclorama commences to go to a greater height, and thus another dream of Gordon Craig's began to be realised. The lighting, designed by Linnebach, consisted of automatically fed arc lanterns open both back and front. Magazines with colour slides and shutters connected to the switchboard by means of steel wires allowed the light to be varied or dimmed. The light coming from the front illuminated the cyclorama, and that from the back hit a reflector which directed light down on the stage and illuminated the acting area.

Optical effects, such as snow, clouds, etc., obtained by arc lamps and optical lenses also made their appearance between 1895 and 1914.

## *Recent English Practice*

This, then, was the position of Stage Lighting in Europe in 1914. There were the two schools, the English method and the Continental. Despite the criticism of those who had witnessed some of the Continental productions, lighting in the English theatres was of a high standard when the cost and available apparatus were taken into consideration, as will be remembered by many when a few famous plays are recalled. All Tree's productions at His Majesty's, the Arthur Collins Drury Lane dramas, the "Blue Lagoon," Oscar Asche's "Kismet," Matheson Lang's "Mr. Wu," the "Blue Bird," "Peter Pan," "Havana," "Waltz Dream," "The Dollar Princess," etc., may be mentioned as instances.

The gas-filled projector lamp made its appearance in 1914.* In this country it was not applied to stage lighting until after the war period. In America, however, they at once began to make steady progress to replace the arc as a light-source for spot lamps having the enormous advantage over the arc that they could be dimmed. Here, therefore, commenced a new step in stage lighting.

Fuchs had defined the incandescent spotlight as—"A piece of Stage Lighting apparatus used for lighting a small portion of the stage or a character to a higher intensity than the remainder and thus *unconsciously* focussing the attention of the audience to either that part of the stage or that character so lighted. It consists principally of a concentrated light source and a lense mounted in a housing that restricts the escape of light to the opening occupied by the lens." The use of this type of spot in stage lighting made it possible to obtain a stereoscopic effect. At last the flatness was taken out of the scenery and characters, particularly in interior sets, without the flicker and occasional hiss of stage arc lamps.

The first batten was soon dispensed with as a floodlighting unit, and became a spot batten, with sometimes as many as twenty spots, each separately controlled by its own dimmer, whilst "boomerangs," which consisted of lengths of steel barrel to which were clamped spotlight projectors, were erected on either side of the proscenium arch.

As mentioned above, these lamps were not in general use in this country until after the War. The credit of their first use must, however, be given to Earnshaw in connection with Frohman's production of "Peter Pan" at the Duke of York's Theatre in 1913. They were of Continental make. After 1918 their use began to grow steadily. They are now, in my opinion, the most useful light unit in any play in which realism is desired.

As it was found impossible to lacquer the high wattage types of ordinary gasfilled lamps owing to the temperature attained, compartment battens, with gelatine colour mediums, etc., began to be used. At first, no other reflector than the white interiors of the compartments was used. Later, standard reflectors of various material were introduced. Originally, no attempt at special design of the shape of the reflector for the particular work was made, but gradually in England scientifically designed reflectors were introduced. To-day, every stage lighting unit is equipped with a reflector which has been specially designed for its particular requirements. Reflectors are usually of broken surface mirror, chromium plate, or prismatic glass, each of which has its special advantages and drawbacks.

The great increase in the intensity of sources available, together with the whiter quality of light they furnished, naturally induced encouraging experiments in the use of colour light in the years following the war. Coloured light may be derived in two main ways, by transmission through some form of filter, or by reflection from coloured material . . . a method pursued by Fortuny and Belasco. In either case, it should be understood that, when incandescent sources are used, mixed or impure colours result. The effect when such light falls on coloured objects, such as scenery or the dresses of actors, naturally needs study.

Many writers on stage lighting have endeavoured to frame rules, and even have presented colour charts showing the effects of coloured light on coloured pigments, but no rule or standard notation can really be given, for without spectral analysis of both the pigment and the light media, one cannot be certain of the result. There is only one way of lighting scenery and costumes, that is, by practical experiment.

## *Cyclorama Colour Effects*

During the post-War period the gas-filled lamp and the projector lamp commenced to influence theatre equipment on the Continent, and Hasait, a stage mechanic, and Schwabe, a theatre lighting expert, produced, by their joint efforts, in Berlin a portable cyclorama and various special lighting units. These were rather fully described by Mr. Groom in his paper before the Society in 1926. Briefly, this form of cyclorama consisted of a number of sheets of canvas sewn together and treated with a white composition, forming a smooth surface. This cloth is hung by a special process, which prevents creases and folds, and it can be rolled away when not required. It was illuminated by a bank of tubular type floodlamps, using a special lamp with a straight line filament, and curved coloured glasses, which gave a spread of 180 deg. of light. Seven colours were used, four shades of blue, and one each of red, yellow, and green, and by blending these any colour hues could be obtained. The method was effective from the point of view of stagecraft, but the cost of the lamps and the low efficiency of the units made the running cost extremely expensive.

Many other units for particular work were fitted with colour screens which were operated by means of steel wires pasing over endless pulleys to a control board situated near the stage switchboard. Basil Dean introduced this method into this country. The newspaper critics did not take kindly to this type of stage presentation. The critics of that period were perhaps rather startled out of an old groove, though in some cases the lighting of the cyclorama was of such a nature as to overshadow the play and the

* As a curiosity, however, it is of interest to mention that a form of "focus lamp" was described by Edward O'Keefe in Cassell's "Technical Educator," so far back as 1895.

actors. The system was installed at one or two theatres, but lived a very short life.

In 1922, at the Admiralty Theatre, Wembley Exhibition, Oliver Bernard, in conjunction with Phillip Sheridan, devised a scheme of colour-mixing on a cyclorama for the spectacle of the Battle of Zeebrugge. The colours used were pink, green, blue, and amber.

Despite the critics' disfavour to the new system of stage presentation, cycloramas were installed at the Old Vic and at the Parry Opera House and the Royal College of Music. These were of amended pattern, inasmuch as they were practically flat, being curved only at the ends. That at the old Vic was treated with a mottled blue colouring, thus resembling the treatment adopted at the Charlottenburg Opera House. Proctor Greig, at the College of Music, tinted the surface pale yellow at the bottom merging into green at the top. In 1928, Terence Grey and Ridge, at the Festival Theatre, Cambridge, employed a plaster cyclorama, using the German method of lighting, where they produced some remarkable plays and utilised highly advanced stagecraft and effects.

The direct use of coloured light, obtained either by transmission of white light through colour-filters or by reflecting it from coloured screens, by methods such as those described above, has recently undergone a modification in the form of scientific mixing of coloured light. Members of this Society do not need to be reminded that the mixture of coloured light is something different from the mixing of pigments; nor that the mixture is not evident when two coloured beams cross each other, but only when they jointly impinge on some object.

By the method of colour-mixture remarkable results may be secured. Colour light-mixing by means of three hues only was not exploited until 1913, when Munroe R. Pevier commenced to use it in America, producing various hues by varying the intensity of the source of light behind each colour. It was not until after the Schwabe Hasait methods had been used that Ridge, at the Festival Theatre, Cambridge, commenced experiments with coloured glasses of red, blue, and green. About this time Volk, an Englishman, produced a model stage with cyclorama lighting, using gelatines. His attempts were exceedingly fine, and whilst Ridge had been using more or less pure spectrum colours, Volk had two screens, red and amber on one unit, bluey green on another, and deep blue in the third. His colour media was ordinary theatrical gelatines. Despite the fact that ordinary commercial gelatines do not yield pure spectrum colours, the results were very fine. Theatre lighting designers were not long in realising the possibilities and the method, but the limitations of the average commercial wire dimmer acted as a stumbling block. Ridge and his partner, Aldred, pointed out that the lumen output of the lamp thus regulated did not decrease at the same rate as the voltage, the lumen output dropping to about 35 per cent. at 75 per cent. voltage, and that during this portion of travel most of the colour-mixing to obtain different hues took place. They, therefore, produced a formulae for a special winding, such that the stops in this section were wound for fine graduation of colour-blending. Even so, the one difficulty in obtaining a winding that would not give rise to "jumps" was still experienced. Ultimately, however, a dimmer with 100 contacts was produced. This gave 50 per cent. luminous output at the thirtieth stud, and has been found entirely successful.

Thus the three-colour process of cyclorama lighting began to be developed by lighting experts and manufacturers and to be a recognised success in this country. It was first introduced in a small amateur theatre in Halifax, then in the Northampton Repertory Theatre, the Garrick Playhouse, Altrincham, the Royal Academy of Dramatic Art, the Shakespeare Memorial Theatre, the Westminster Theatre, the Royal Opera House, Covent Garden, Citizen House, Bath, and the Cambridge University A.D.C. Theatre. All these theatres can, by means of the three-colour additive method of colour mixing, produce on the cyclorama any spectral hue and imitate even an Italian sky or a November fog, purely by the aid of light alone. This represents a distinct advance on the German system where seven shades of colour are used to obtain the same results.

The nature of the surface of the material in which pigments are applied and even the manner in which they are applied is of great importance. Thus, coarse material, such as canvas or heavy woollen material, appears under coloured light to have the qualities of tapestries and velvets. Many of the costumes at the Royal Opera House, the Old Vic, and Shakespeare Memorial Theatre are little more than rags under the light of day, yet appear rich and beautiful under the stage lighting. Much thought and expense have been expended in the cinema world on the choice of fabrics during the last few years, resulting in some very beautiful colour effects for various designed curtains, and in some cases the use of the cyclorama has been included.

Let me here sound a note of warning respecting cyclorama lighting and repeat the words of Mr. K. Searle who in the discussion on Mr. J. B. Fagan's paper emphasised that care must be taken to ensure that the lighting in no way distracts attention from the actors but is used to assist their efforts. Many producers, particularly amateurs, are inclined to overlight, and then wonder why the act or scene has not "got over." Fagan in his paper said:

> "First the Play,
> Second the Acting,
> Third the Lighting."

Thus, definitely placing the lighting as an aid to the first two.

## *Shadows and Plastic Expression*

Now we come to what Fuch described as "plastic expression." Here colour plays practically no part. The high lights, shadows, light and shade, are purely a matter of intensity and direction. At this stage the use of shadows should be mentioned. To produce a shadow by means of light was, a few years ago, regarded practically as a crime. To-day the focus spot has made their use possible, and in many cases they give just the touch of realism that a scene demands. Major Creighton, who produced the Tattoos at Wembley and the recent Pageant of Parliament at the Albert Hall, has obtained some exceedingly fine effects with gigantic shadows, not merely effects of light and shade, but shadows cast by the characters themselves, often distorted. Creighton is a most unusual producer, often asking for the impossible and, what is more, getting it! His schemes of colour, light, and shade in the Pageant of Parliament were the finest piece of pageant work I have seen. He mixed symbolic scenery with realism in character and costume with a blending of lighting which gave physiological expression to the moods of the various episodes. Komisarjevsky in his production of Macbeth at the Shakespeare Memorial Theatre made great use of the lighting in the same way. Here not only the scenery but the costumes were partly symbolic with even a touch of modernism, but all through the tragedy there appeared the drab coloured light, particularly on the cyclorama which reinforced and emphasised the tragic theme and gave a physiological background for the actors.

## *Limitations of the Cyclorama*

Many of you will no doubt wonder why the system of cyclorama lighting is not universally employed by theatres in this country. There are many reasons. Firstly, the cost of the alteration of the theatre in having to raise the roof of the stage. Secondly, the

London Building Act, which limits the height of buildings, would no doubt make it impossible, whilst the touring of plays about the country would only be possible if all the touring theatres were equipped with standard apparatus and a stage of standard size. It is only in such theatres as Covent Garden, Drury Lane, and the Coliseum that such enormous heights can be obtained.

Another reason is that every play does not lend itself to this mode of presentation. The Coliseum with its "White Horse Inn" production was evidently the type of play that required it, yet when Sir Oswald Stoll used the same method for variety at the Alhambra it was found to be a failure. Again, Hassard Short when he produced "Waltzes From Vienna" had the cyclorama removed and used another of dark blue velvet with an entirely different method of lighting.

Personally, I do not thing that the installation of a cyclorama, with its permanent lighting, is often of good value in a theatre which has not a settled policy. For Repertory Theatres where very often a different play, but of the same nature, is staged every night such as the Old Vic, the Shakespeare Memorial, the Festival, and the Westminster Theatre, the opera and the countless small Repertory Theatres in the provinces, it is ideal. But for the theatre which is constantly presenting plays of a varying nature, say a farce during one period, and possibly following this with a musical comedy and even a play transferred from another house, then the outlay is not warranted. Many of our London theatres are owned by one party who lets the theatre to another, who probably has to provide his own special lighting and does so for that play only, as he will probably vacate the theatre at the end of the run. This does not mean that cycloramas are not used in these types of plays, but they are always of a temporary nature and abbreviated pattern, and the lighting is arranged accordingly. Such plays as "Conversation Piece," "Helen," and all Charlot revues used the temporary cyclorama which is of a pale grey velvet, and even then these are probably only used for one scene. Frank Collins, Mr. Cochran's stage director, has produced some wonderful effects on this type of cyclorama.

Where it is possible theatres that permanently instal a cyclorama should use one of solid construction, preferably built of cement, and treated with a flat white water distemper. The use of oil paint even of a flat nature should be avoided. The cyclorama at Stratford-on-Avon, the Westminster Theatre, the Festival, and many other theatres are of this pattern. That of the Shakespeare Memorial is of unique design, as it is entirely carried on the fly rails and does not touch the stage. It can be moved up or down stage as required, and when not in use fits snugly under the fly connecting bridge at the back of the stage. It is a splendid piece of constructive engineering. The weight is 22 tons, and one man can manipulate it with ease. The lighting is carried on the same framework and moves with it up and down stage. There is a constellation of thirty stars which can be varied as desired by the producer. The Westminster Theatre has made more use of its cyclorama than any other in London, and Tyrone Guthrie, who produced many plays there, is to be congratulated on the fine effects, particularly his production of "Jonah and the Whale" and "Tobias and the Angel."

## *Spotlights*

Very little was done before the war in the use of spot lights in the front of the house, beyond the use of two or three arcs which in variety, revue and musical comedy were used to follow the artists or dancers. Tree, however, made great use of fixed arcs throwing from the dome of His Majesty's Theatre.

Robert Atkins at the Old Vic, was a great believer of "forward" spot batten, and hung out in the auditorium a bank of projector lamp spots which was concealed by a decorative feature and this method was followed at Sadlers Wells. Then in one or two isolated cases spots were hung on the face of the circles for special plays.

Fig. 1. Lighting Towers equipped with 2,000 watt spot lanterns as used in American Theatres and by Hassard Short in his productions of "Waltzes from Vienna" and "Wild Violets" in London.

Hassard Short started a new phase in stage lighting with his first production of "Waltzes from Vienna" at the Alhambra. He had twenty-four spot lanterns concealed in housings fitted to the front of the circle, each controlled by its own dimmer. This production was followed by the Palace Theatre production of "The Cat and the Fiddle," thirty being installed. Producers quickly grasped this new method which had been used in the cinemas of America and this country just previously. In Cochran's production of "Cavalcade" at Drury Lane, Noel Coward and Frank Collins, the stage director, went one step further and had installed spot lanterns fitted with colour screens which could be operated electrically from the switchboard. Now nearly every important theatre in London has this type of lighting installed, whilst the theatres in the provinces in such towns as Blackpool, Manchester, etc., have followed the lead. In the new theatres these spots are looked on rather with an evil eye by the architects who, however, are now beginning to overcome the difficulties of concealing them on the face of the circles, and of providing them with adequate ventilation.

The use of the projector lamp would be developed more if the lamp manufacturers could produce a lamp with a point source of light. Some of the pin focus work with this type of lamp is practically impossible, owing to filament images, without the use of optical attachments which reduce the light so much as to render them useless, and I look to the day when the lamp manufacturers will give us a filament which will be like the cylinder of lime and be virtually a ball of white fire.

In 1921 a special form of incandescent spotlight was invented to overcome the filament image. This represented a distinct step forward and in many small theatres has replaced the arc spotlight used from the back of the gallery. Both at Covent Garden and at Shakespeare Memorial banks of these lanterns using 30 volt 30 ampere projector lamps are concealed in the main ceiling to illuminate the fore stage and the acting area. Twelve of these lanterns were used at the Albert Hall in the Pageant of Parliament with an average throw of 120 ft. The

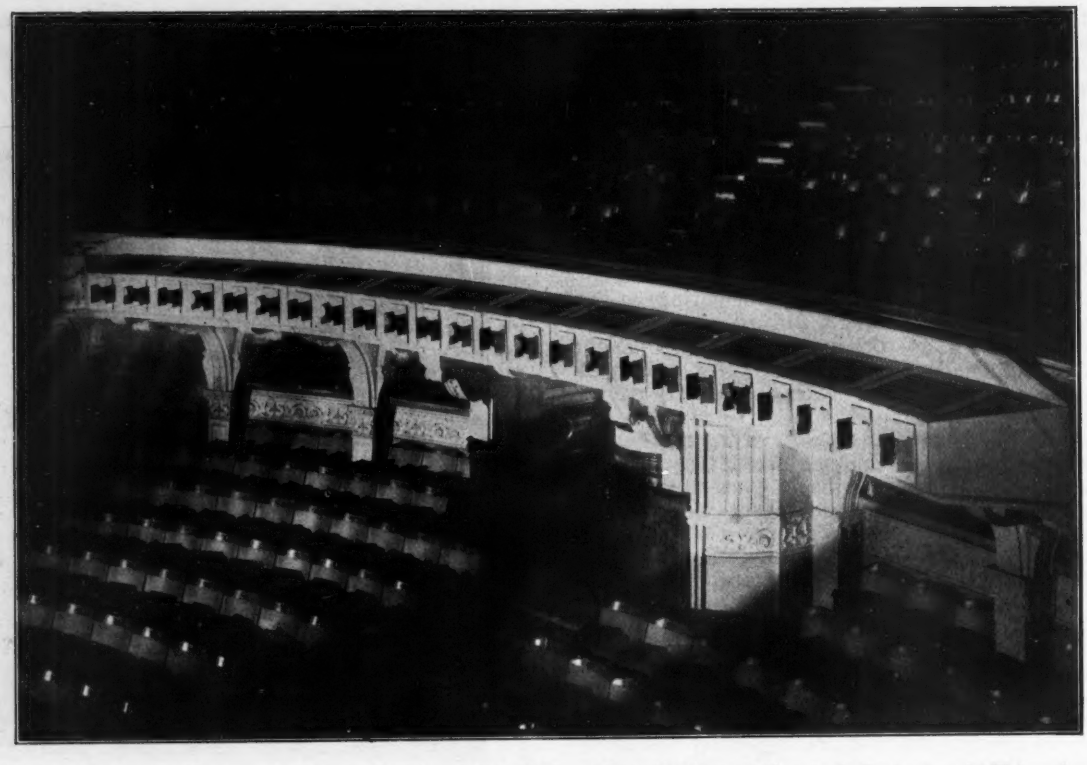


Fig. 2. Illustrating the Fixing of Spotlights to the Front of the Circle, originated by Hassard Short in the Production of " Waltzes from Vienna " at the Alhambra.

spotlight uses a combination of specially curved reflectors and refractors, together with condensers and lenses. Unfortunately, it is rather expensive for the smaller theatres, but its efficiency in the theatres is well worth the extra cost. It has the distinct advantage that a 6-inch diameter pin focus can be obtained at this distance. It has one disadvantage; its size prevents it being used as a unit of a spot batten.

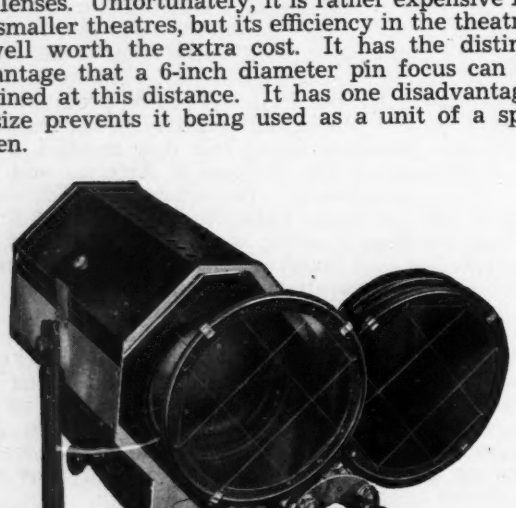


Fig. 3. 1,000 watt Spot Lanterns which are fitted into the Circle at the Theatre Royal, Drury Lane, the colours being changed by means of electric solenoids.

The use of the spotlight set manufacturers thinking of a reflector to enhance the light in the cheaper type of spot lantern. Mirror reflectors were promiscuously fitted behind the lamps with practically no attempt to ascertain correct focal length. In addition, the silvering lasted only a short time. Happily this has now been altered and chromium-plated reflectors which will stand up to the heat, which are easily cleaned and which are so designed that at any position they are always in focus with lamp and lense without readjustment, are to-day on the market. One rather peculiar use of such units by David Belasco, the well-known American producer, may be mentioned. Working with the Fortuny system, Mr. Belasco hangs a row of spots just over the proscenium arch, pointing down stage, and projects the coloured light from these spots into curved circular reflector discs which in turn throw a diffused light over the cyclorama.

## *Dimmers*

So far attention has been devoted mainly to lighting units. Recent advances in the control of intensity of the light by means of dimmers should next be mentioned. The equipments available in 1880 consisted of a number of resistance dimmers, much the same as our present-day type, but they were so unreliable that in this country the liquid dimmer gradually took their place. The use of this type persisted, despite the occasional invasion of German and American patterns, until about 1929, when British manufacturers succeeded in producing really efficient designs. The metallic type of dimmer has since then gradually replaced the liquid type. The advent of the " super-cinema " under U.S.A. control, with fully-equipped stages, saw the introduction of the American type of switchboard, with arrangements for pre-setting a number of scenes. As, however, the pre-setting is only of value in regard to the switching, and not the dimmer positions, it has gradually died out, and, in any case, found little favour in the legitimate theatre. Automatic boards which, on the pressing of a button, produced a preselected effect by means of drum controller motor operated, etc., are being used for spectacular effects on the stages of the cinemas, for colour effects and for organ designs. These likewise are not favoured for the use of stage plays. The reactance dimmer has made some progress in Germany and America, as has also the remote control of intensity by means of thermionic tubes, a method which is being used in some of the theatres of the United States. Experts in this country are experimenting with this type of

control, but, so far, the heavy costs have prevented their wide adoption.

During the past year or so the remote control of dimmers by means of electric solenoids, has been developed and patented by M. Mansell, a member of this Society, and it was adopted by Mr. Basil Davis, the consulting engineer for the new stage lighting equipment at Covent Garden Opera House.

## *Equipment for Super-Cinemas*

During the past few years, most of the big super-cinemas built in London and its suburbs have installed elaborate equipments for the production of stage spectacles. I refer to such houses as the Gaumont Palaces at Lewisham, Hammersmith, and Wood Green, the Regal, Edmonton, the Troxy, Stepney, etc. These houses are so big, and the majority of the spectators are so far away from the stage, that high intensities of illumination on all the apparatus are needed. In such cases battens which in any ordinary theatre would utilise 100-watt lamps have to accommodate 200 and 300-watt lamps. In addition, these types of houses are using mobile spot lanterns of 2,000-watts size, frequently as many as twenty for each stage.

As an illustration of the magnitude of modern stage lighting in cinemas, the connected loads of some of the stages in this type of house may be of interest.

| Cinema Theatre. | Load in Kilowatts. |
|---|---|
| Gaumont Palace, Lewisham ..... | 300 |
| „ „ Wood Green ..... | 250 |
| „ „ Chelsea ..... | 250 |
| Regal, Edmonton ..... | 260 |
| Troxy, Stepney ..... | 120 |

## *Comparison With American Practice*

It is of interest to compare these data with the recent installation at the Roxy Theatre, Radio City in New York, where the connected load is 2,500-k.w. The stage in addition to battens, footlight and cyclorama lighting equipment has fifty 2,000-watt spot lanterns, and the switchboard has 190 controls. In the Radio City music hall the stage board has 4,300 handles, each of which may be pre-set to the different combinations, and requires three operators. There are four distinct lighting bridges hung over the stage, which can be electrically raised, lowered or tilted. Each bridge is equipped with sixty-two 2,000-watt spots and four 70 ampere arc spots. In addition there are two lighting galleries on either side of the stage, suspended from the flys with another forty-three 2,000-watt spots and eight 150 ampere arcs, six movable towers with six 150 ampere arcs and eighteen 2,000-watt spots. On each proscenium wall forty 2,000-watt spots are fitted. There is thus a total of 388 2,000-watt spots. The battens have 500-watt lamps in each compartment. The cyclorama seems to be rather small as there are only seventy-six 1,000-watt lanterns to light the upper section.

This will give you some idea of American practice in stage lighting. We are told by three experts who have visited America that their equipment is generally similar to ours, except that they always use about four times as much energy. Whenever an American show is brought to this country we in the theatre lighting world are always astonished at the number of lighting units that are demanded. At one time they used to bring over their own equipments. but it is now the custom to obtain their apparatus here, which is surely a striking tribute to British manufacturers.

## *Continental Practice*

Let us now compare the American theatre with those on the Continent and in this country. As our first example we may take the Berlin State Opera House which was re-equipped about 1929. There is a special sub-station which transforms down from 6,000 volts and the transformers have a connected load of 1,800 k.w. for power and incandescent lighting, and generators giving 320 k.w. for d.c. circuits. There are 105 plug points in various positions on the stage for arc lamp connections and 150 for incandescent spots of various wattages The cyclorama top is illuminated by 132, 1,000 watt blue lanterns, 30 red, 30 green, and 30 amber, giving a total load of 222 k.w. The Shakespeare Memorial Theatre has a stage-connected load of 120 k.w. In addition 38 1,000-watt spots are used in various positions on the stage and concealed in the auditorium. The battens have 100-watt lamps and the cyclorama lighting units are 150 watts. In comparing this with our American and German examples we must remember that the stage is relatively small. When it is mentioned that the whole of the Memorial Theatre could be placed on the stage of the Schauspielhaus, Dresden, the size of these great Continental theatres will be appreciated.

## *Novel Methods at Covent Garden*

This year 1934, saw the reorganisation of the stage lighting at the Royal Opera House, Covent Garden. The new lighting equipment, comprising the latest designs of stage lighting apparatus is entirely of British manufacture. Special cables, 11,000 volts, have been brought to the theatre sub-station and transformed down to 230 volts A.C. three-phase. The stage connected load is 700 k.w. for incandescent light, and 150 k.w. at 100 volts for D.C. which is fed from an independent D.C. supply.

The cyclorama is floodlighted by 148, 1,000-watt lanterns for general illumination, having 80 units Blue, 34 red, and 34 green. Horizon lighting at the bottom is by means of mobile trucks having 72 500-watt flood lanterns, which are divided up into three primary colours of red, blue, and green, the area covered being 15,000 square feet. The additive method of blending is used to obtain the various stage colourings. Gelatine colour media are used. The orthodox lighting for the ordinary type of scenery is by means of five battens with 150-watt lamps in each compartment. These are arranged in sections. Between these are fitted 1,000-watt acting area lanterns to give top lighting to the stage when the cyclorama is used. These lanterns are designed to give only 15° dispersion of light, the result being

Fig. 4. Acting Area Lanterns installed at Covent Garden and at many of the Super Cinemas for projecting Light down on to the Stage, with a dispersion of only 15°.

obtained by the design of the reflector and without the use of lenses. The cyclorama is of circular shape and constructed of canvas carried on a circular track so that, for change of scenes and when not required, it can be rolled up in one corner of the stage in thirty seconds by electric drive. Owing to the small time available a temporary cloth was used during the last opera season, but the permanent cloth which has now been installed is of specially woven material treated with a "dope" of matt white finish. A lighting bridge, on which operators can comfortably work, has been provided over the proscenium. This is equipped with twenty-four lanterns of different types, some arc lanterns for producing optical effects such as clouds, etc., and others of the 1,000 and 2,000-watt projector type. Immediately underneath the bridge is hung a combined spotting and flood batten. A travelling "chair" has been provided under the bridge so that adjustments to the lanterns can be made in between the scenes, whilst all the spots have been fitted with special worm operated focus attachments. There are on each side of the proscenium opening special 3-tier portals equipped with 1,000-watt spotting lanterns. An additional three spots using 30 volt 30 ampere type projector lamps are concealed in the auditorium dome and the colours of these can be changed by means of electro-magnets operated from the stage switchboard. Altogether there are available seventy-six plugs in the stage floor to which moveable apparatus can be connected, whilst in the flies there are eight incandescent plugs and eight arc lamp positions for spots, etc.

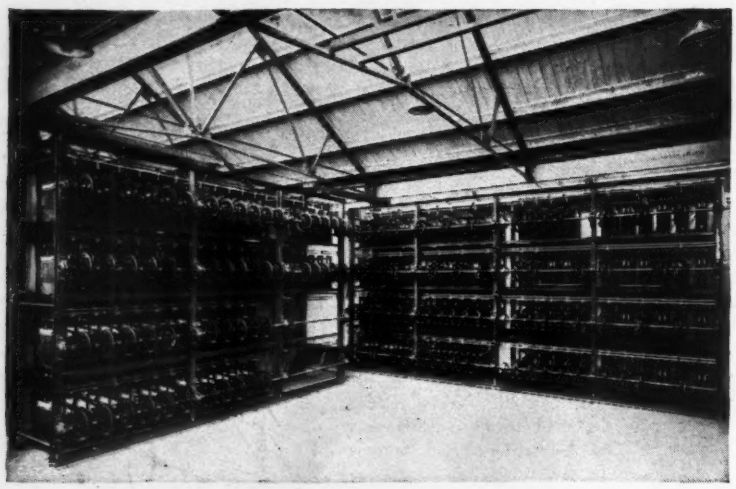


Fig. 5 Remotely controlled Dimmer Bank which is fitted into the Basement of the Royal Opera House, Covent Garden.

An entirely new method of dimmer control has been installed. Actually the dimmer board is 34 ft. long and 8 ft. 6 in. high, and is accommodated in the stage basement. The control board is on a special platform at the side of the stage, and measures 5 ft. 9 in. by 2 ft. 9 in. The method, as already mentioned, is due to Mr. M. Mansell, one of the members of this Society. The main motive power is manual, by means of master wheels operating a main shaft. Any dimmer can be connected to this shaft by means of electro-magnets, which will either raise or lower the dimmer. The magnets are operated by means of minute switches on the control board. Each dimmer records on a specially designed instrument, the percentage of light in every circuit being according to the position of the dimmer brush travel.

The current for the magnetic clutches is obtained from a 12-volt battery, which is kept charged by the constant floating system invented by Mr. Basil Davis, the consulting engineer to the theatre. The lighting, in conjunction with the very effective scenery designed by Gabriel Volkoff for Wagner's "Ring," received very favourable comment in the Press. There is no doubt that for opera or Shakespeare, where a different piece has to be played each night, the scenery and system of lighting is not only more effective than the old method but also very much easier of operation.

## *Projection Effects*

One special feature is the provision made for the projection of scenery, a method which was used to some extent during the last opera season. As previously mentioned, the use of optical effects, such as clouds, sea waves, and snow storms, has been familiar for some years. Some of the Continental cloud machines exhibit really fine craftsmanship. The light source is a 3,000-watt gas-filled lamp, around which are mounted an average of twenty projector attachments, each fitted with a slide which is an actual photograph of a cloud. The whole of the apparatus is made to revolve by means of one motor, while two other motors control vertical movements of each projector attachment. The use of such apparatus in the English theatre is restricted by its enormous size and costliness. The Coliseum, St. Martin's Theatre, and Mr. Christie's Opera House, in Sussex, are the only cases I know where this apparatus is at present installed.

An outstanding advance on the Continent has been the projection of scenery on to the cyclorama. The light-sources used are 150-ampere arcs, and the lantern slides themselves are kept cool by means of either blowers or water baths. The optical system is so designed as to give a very wide angle picture. A much larger slide than that used in the ordinary lantern slide is therefore necessary. If the design to be projected is only required to give an atmosphere or "symbolic effect," the problem is simpler, as a lantern of the type known as a "Linnenbach" is used. This uses as a light source, which should approach a point source as nearly as possible, either an arc or a projector lamp, preferably of the 30-volt 30-ampere type. This is housed in a lantern with only a 2-ft. opening, and the interior of the lantern is finished a matt black. Glass slides on which are painted the design are used, and the results on the cyclorama or back cloth are of the "blurred shadow" type. This method has its use in plays where fantastic and impressionistic methods are aimed at.

In this country both methods have been used with English apparatus, notable examples of which were the angels' wings which covered the whole width and height of the cyclorama at the Westminster Theatre for the performance of "Tobias and the Angels." This slide was painted by Miss Molly McArthur, one of the most progressive of our scene designers, who adopted the other ("Linnenbach") method in the Old Vic production of "The Cherry Orchard." Another example of projected scenery was furnished during the last Royal Opera season, where still cloud effects in conjunction with projected scenery views were used in the production of "The Ring." The representation of the distant Palace of Valhalla was obtained by the same method. On the Continent they are beginning to use such projection devices much more extensively. The system known as G.K.P. has been used at the Burg Theatre, Vienna, and also at the Odeon Theatre in Paris. The slides in this case are made by mechanical means and then coloured by the artist. A large scale model is first made and is then photographed with the camera in the position that the projector will eventually occupy. Thus all distortion due to the somewhat awkward position of the lantern is overcome. The resultant photograph is finally enlarged to the size required for use in the optical lantern and then

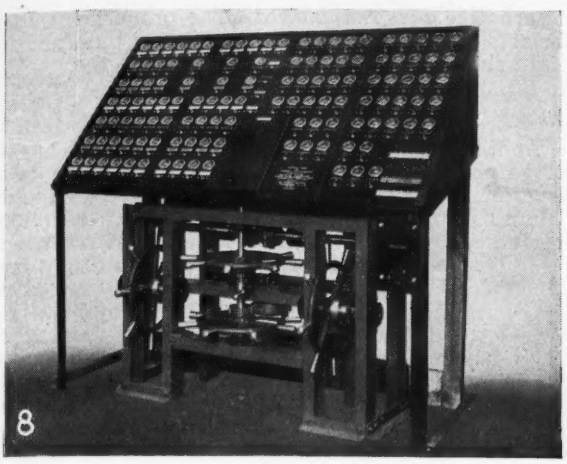


Fig. 6. Control Board for remotely controlling the Dimmers illustrated in Fig. 4.

coloured by the artists. The lantern used is fitted with an optical system which gives an angle of 85 degrees. It is usual to fit the apparatus on a bridge over the proscenium arch. The apparatus is, however, very costly.

Strobach, at the Cologne Opera House, has used a German system having a less wide dispersion than that attained in Vienna. Three projectors are used, which makes the setting of the lantern to get the joins in the correct positions rather a problem for the artist!

The use of projected scenery in this country is very limited, and certainly does not warrant the use of such expensive apparatus. In fact, no theatrical producer would dream of spending the requisite amount. It is only in the State-aided Opera House of the Continent, or in such theatres as Drury Lane, Covent Garden, or the Coliseum, in this country, that such methods are likely to find favour. Certainly a permanent installation at any of the theatres in this country seems unlikely to materialise.

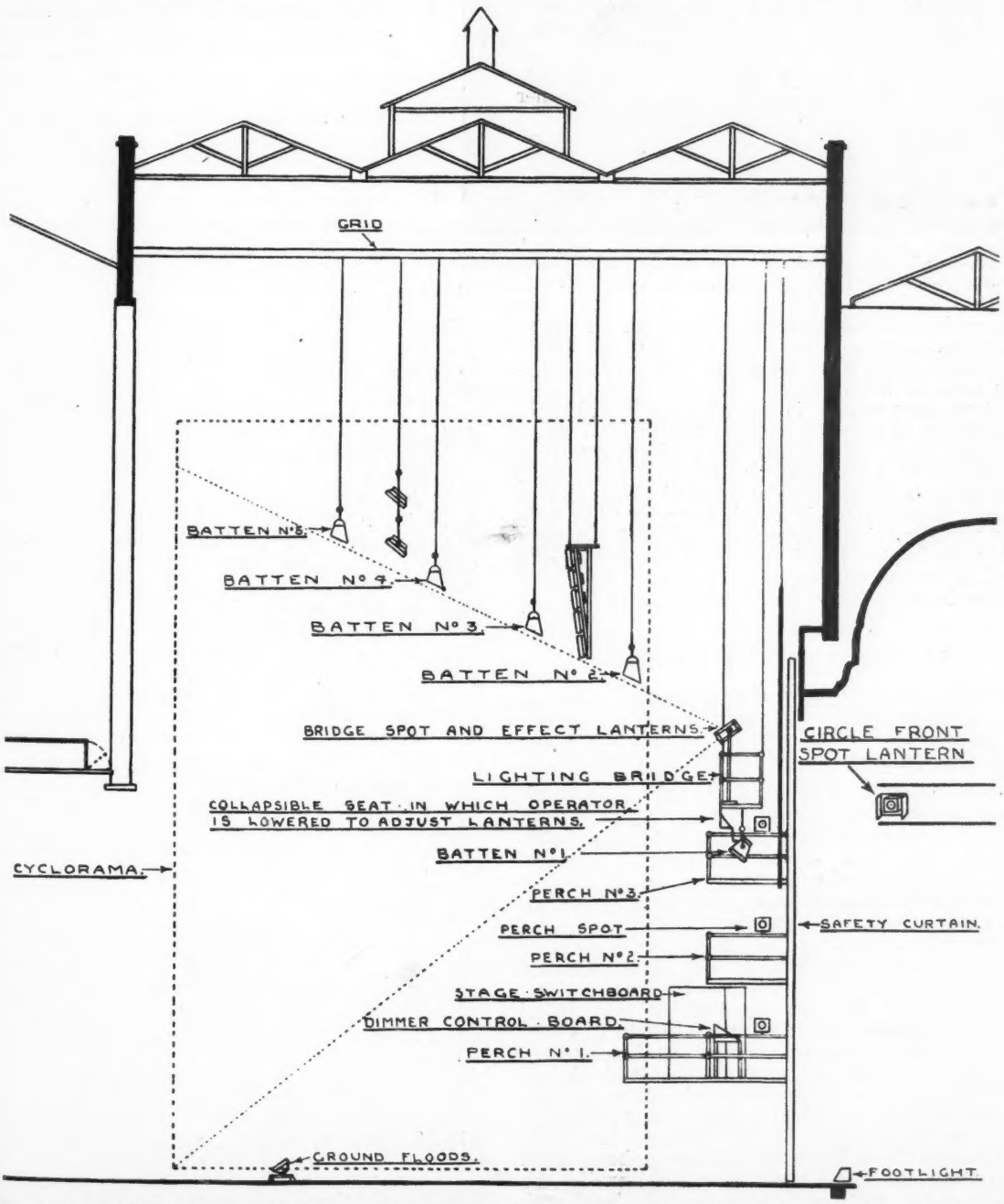



Fig. 7. General View of the new Stage Lighting Installation at Royal Opera House, Covent Garden, showing Battens, Footlights and Bank of one hundred and fifty 1,000 watt Lanterns used to illuminate the Cyclorama.

So far all the results have been obtained in this country by adapting the existing type of lanterns which are used for clouds, flames, etc., but Mr. C. Smith has recently devised an apparatus (the Mutochrome) which was demonstrated to this Society some years ago, and is extensively used in the textile and other industries.

This, if developed on Continental lines, might give sensational results in the theatre, but, as indicated above, the limited opportunities and relatively high cost of such apparatus are likely to continue to prove a difficulty. One is rather surprised that the art of the cinematograph picture has not been more extensively used in the theatre. The author can recall only two cases where it has been used with any great degree of success, namely, the production of "The Blue Bird" before the war, at the Haymarket Theatre, where a film was used in conjunction with the stage lighting showing a flock of birds, and in Charlot's recent revue, in which a non-flam film projector using an incandescent projector lamp was fitted to the front of the circle to give the illusion of a packed farm cart passing down a country road in a direction heading away from the audience.


*Courtesy of "The Electrical Review."*

Fig. 8. An example of Projected Scenery (The Palace of Portal to Valhalla seen in the background, in "Das Rheingold," during the last Opera at Covent Garden).

## *Special Types of Lamps*

Mercury Vapour Lamps are, as a source of light for stage work other than "effect-lighting," unsuitable, for in spite of their high efficiency and the strong blue constituent in the spectrum, the fact that they cannot be dimmed is an evident drawback and has limited their use in this country, although they have been used on the Continent for blue lighting on the cyclorama. It is chiefly when used in conjunction with a screen, as sources of ultra violet radiation for fluorescent effects, that such lamps are used—for example, in producing such effects as ghost scenes and pantomime spectacles. A recent example was the prologue of the film of "The Invisible Man," in which a pair of trousers only were seen walking about the stage, no other part of the actor being visible. The carbon arc sometimes used in this way is less successful, as a certain amount of stray light is apt to render other objects slightly visible, a fact which somewhat spoils the illusion. There are ultimate possibilities in the use of luminous discharge and hot cathode tubes as light-sources for stage work; here again, before such sources can be adopted for a permanent installation, means of varying the intensity, i.e., "dimming," will have to be found. The use of shutters sometimes contemplated as an alternative does not answer. The producer needs to be able to vary the intensities of green, blue, and red light simultaneously and to different degree.

## *Views of Producers*

At this stage a quotation of statements of eminent stage producers in regard to lighting may be of interest. Louis Hartmann, in a paper presented to the Illuminating Engineering Society (U.S.A.) in 1923, remarked: "I woke to the realisation of what light means to the stage, how valuable it is, and how much it assists the drama. When we speak of light in the commercial field it is generally treated as a slide rule proposition; it resolves itself into a thing of mathematics and formulae; but in theatre lighting we have no formulae. The shapes of lanterns and lens may vary; but what matter, it is the intelligence you display in handling them that really counts—something that can come to you only through experience."

Also Claude Bragdon, before the same society in 1924, said: "Though all people react emotionally to light, whether they know it or not, few are able to *see* light—to see it analytically, that is, as a musician hears music—distinguishing the sound of separate instruments and hearing in the harmonies their component sounds. It is music which has educated the sense of hearing to this pitch of perfection. The sense of sight to-day, not as a serviceable faculty, but as a source of aesthetic enjoyment, is only just emerged from that rudimentary state in which hearing was before the rise of the musical art.

"In our great plays, greatly acted, the lighting should be strictly subordinate to the wish of the author and actor, and should be so good that it can be forgotten by the spectator."

An English producer's view is very forcibly stated by Herbert Prentice, of the Repertory Theatre, Birmingham, in an introduction to Messrs. Ridge and Aldred's book on "Modern Stage Lighting":

"Many people consider they have said all there is to say when they state 'the play's the thing.' I agree, but what is the play? The play combines all the activities relative to the composite whole, namely, the words of the text, scenery, costumes, make-up, effects, lighting, etc. The question of stage lighting, colour mixing, etc., is so vast and complex that it must be taken seriously; although the technical side must be left to technical experts, the applied side must be thoroughly understood to be appreciated. Avoid fancy lighting for its own sake. There will be temptations, and probably the thought that because a stage looks colourful it is good; it may be thoroughly bad. A lighting plot means something, and must convey something to the uninitiated—in other words,

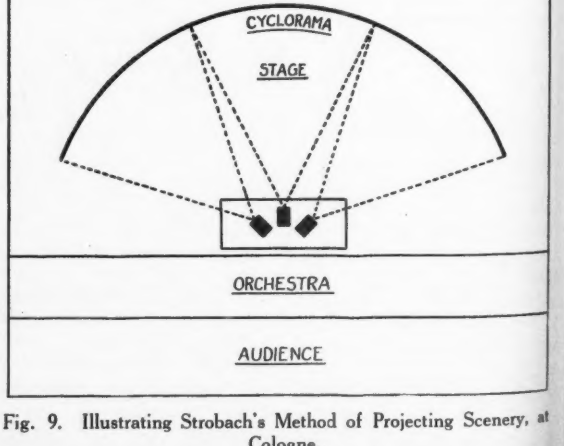



Fig. 9. Illustrating Strobach's Method of Projecting Scenery, at Cologne.

it must interpret the spirit of the scene, without the public being conscious of the mechanism of it."

It is therefore seen that, once having provided the apparatus, which must be of flexible and adjustable design, its use is primarily one for the artist, who has none or little time for such things as lumen output, foot-candles, or the inverse square law. Furthermore, once the apparatus is designed and handed over to him for use, there is no reason for his knowledge of such things, but there is definitely required a knowledge of the additive and subtractive methods of colour blending for light and pigments. Definitely the illuminating technician has his place in the design of the apparatus, which, of course, must be influenced by his practical experience in the theatre, which can only be obtained by long years of stage practice.

We in the entertainment world form a species of race on our own. That race is again divided into, shall we say, clans such as The Drama, Opera, Repertory Theatre, Musical Comedy, Variety, The Cinema, The Pageant, etc., each of which has its own peculiar customs and procedure, and each brings its own lighting problems, which differ according to the class of entertainment to be provided.

And so to this year of 1935 one wonders what it will bring forth. I look to the day when theatre colour lighting will be used in the big film studios. Colour light will be photographed and reproduced by the camera, and in a similar way television will advance and the wonders of transmission of colour light will eventually be obtained.

## *The Lighting Console*

Fagan, in his paper before this Society, in 1919, stated:—"The day is not far off when we shall see the electrician an artist as well as a technical expert, seated at his switchboard like a player at an organ, sending forth the rhythmic harmonies of light that shall be as music to the eyes, swaying strange, subconscious moods in the audience, in perfect time with the unfolding of the drama in which he himself is playing a part of no mean importance."

In this year of 1935, that prophecy of Fagan's has come to pass in the invention of the "light console," by Frederick Bentham. This follows a scheme similar to that at Covent Garden, in that the dimmers, contactors, etc., are placed in some position remote from the stage acting area. The whole of the dimmer gear, *as well as* the switching, is controlled from the one unit. The light console so far resembles an organ console in that a large number of colour circuits must be simultaneously controlled in one case, and a large number of stops (tone colours) in the other. There the similarity ends. There is *no* equivalent to the musical scale in light, and therefore the two keyboards (manual) bear no similarity to an organ keyboard.

To make a comparison with the direct operated board each keyboard represents a grand master wheel, whilst the stop keys represent the clutches for locking the various dimmers on to the shaft. These grand master keyboards (unlike the usual grand master) control not only the dimmers up and down at varying speeds, but also circuit switches in series and in parallel with the dimmers. The manual keys are equipped with a double touch, second or heavy touch producing a reversal of the effect of the first, whilst special keys are provided so that an individual dimmer or group of dimmers can be preset to stop at any position, either going up or down. The console will give various speeds of dimmer travel from 5 secs. 7½—10—20—40 up to 30 mins. or longer, as desired, by merely using the manual key and pedal contact for the speed concerned, electrical speed indicators being fitted. Various "toe" pistons provide preset movements if the hands are too busily engaged. Full stage and general dim effects are available. The depression of *one toe-piston* cancels everything else on the board, and produces either a dim, raise, blackout, or a full-up with the *one single action*. The action is electric throughout, and the apparatus operates at 15 volts. Some of the various possible combinations are:—

(1) Preset of switches for 24 scenes.

(2) Preset of dimmers for 12 scenes.

(3) Simplified grand master cross control.

(4) The raising of one dimmer whilst its neighbour is going down on the same colour shaft.

(5) The setting of the dimmers to operate over a long period without any attention on the part of the operator.

(6) The pre-selection of continuous moving cycle of colour, giving 24 adjustable sequences.

(7) Variety of speeds of individual dimmers.

(8) The console is designed to operate any type of active dimmer unit although primarily designed to operate the Mansell system previously mentioned. It may operate either wire resistances, variable chokes, thyraton tubes, etc., or retaining the same appearance; if hot cathode tubes are used for cyclorama lighting may work with shutters or solenoid control of colour operation.

(9) It is portable and may, for rehearsals, be placed in the stalls gangway next to the producer, being fitted with a multiplug and trailing cable.

(10) Apart from the use of the above for opera, stage plays, etc., it is believed that the control, working in conjunction with a really comprehensive stage equipment, will render possible interesting and rapid variations of light and effects in simple settings, draperies, etc., such as will themselves form a source of entertainment.

## *In Conclusion*

At the present time instrumental music is considered far more important than vocal. May not the same happen in the case of light?

This, then, concludes my talk on the "Cavalcade of Stage Lighting." There are many items which have been mentioned only very briefly. Much more time might, for example, be extended on dimmers, but it was felt that in a paper before the Illuminating Engineering Society precedence should be given to light-sources and lighting equipment.

## *Bibliography*

For the benefit of those who may like to delve into the subject more deeply, I commend the following works:—

"The Development of the Theatre," by Allardyce Nichols, M.A. (George G. Harrap); "Stage Lighting" (an American text-book), by Theodore Fuch (George Allen and Co., Ltd.); "Stage Lighting," by C. Harold Ridge (Heffer and Sons, Ltd.); "Colour," by Arthur MacMorland, D.A. (Reeves and Sons, Ltd.); "Stage Lighting Principles and Practice," by C. Harold Ridge and F. S. Aldred (Sir Isaac Pitman and Son, *in the Press*).

I tender my thanks to Mr. J. S. Dow, who has placed literature available from the Society at my disposal; to Mr. C. Harold Ridge for his loan of lantern slides and the checking of historical data; to our President, Mr. H. Hepworth Thompson and to Mr. Gillespie Williams, of Holophane, Ltd., for the loan of various slides (The Capitol, Didsbury and The Plaza, Rugby); and to the directors of the Strand Electric and Engineering Company, Ltd., for the loan of apparatus and the use of slides illustrating the Shakespeare Memorial Theatre, Covent, Garden, etc.

I am also indebted to the Westinghouse Brake and Saxby Signal Co., Ltd., for the loan of the rectifier used to obtain direct current for the demonstration with mercury vapour lamps in the course of the address.

# A Cavalcade of Stage Lighting

## DISCUSSION

Mr. C. HAROLD RIDGE, in opening the discussion, said the greatest compliment he could pay the paper was to ask the Society to give another evening to the subject, and to ask Mr. Applebee to deal in more detail with 1934 and 1935. The subject was too large for one evening, and it was difficult to know where to begin and where to stop in attempting to discuss it. In his view this country now led the world in the sphere of stage lighting, and it gave him the greatest pleasure to say this because in the past he had held up the Continental theatre for admiration as compared with our own theatres. The paper, however, showed the tremendous strides we had made here since 1930 Reference had been made in the paper to the Cambridge Festival Theatre, and it was believed, when it was re-opened in 1926, that it was the last word in Europe—neglecting the mere matter of size—but it was, in fact, now a museum piece—after running for eight years! This demonstrated the progress that had been made. The Festival and other theatres of about the same period used foreign plant, and, perhaps, the object lesson was not wasted. Our own people had now beaten the Continent both in scientific design of apparatus and the control of it. The most interesting and important job in this country during 1934, in his view, was Covent Garden Opera House, and this was an entirely British job. It was amusing to note that some of the German technicians who came over here experienced great difficulty in understanding and using our simple three-colour process of colour mixing, showing that they did not understand the real theory underlying the process, although it was in the German theatre that it originated. One thing in which we were disgracefully behind, however, was the manufacture of efficient glass mediums for the three-colour process, and it was time our glass manufacturers bestirred themselves and provided what the theatre so badly needs. The Pevear colours mentioned by the author were too expensive to import, but there was no reason that he knew of to prevent such glass being made here. Would the author say whether there was any hope for the future in this matter? The present position was unsatisfactory because some of the best mediums were not allowed by licensing authorities on account of their slightly inflammable nature, whilst gelatin mediums, especially the blues, faded very rapidly in use, and thus were a source of great expense.

Speaking of the use of films in stage plays, Mr. Ridge said that as far back as 1928 he saw Piscatòr at the Piscator-bühne in the Nollendorfplatz, Berlin, use films in one of the productions. He not only used the film for subsidiary action, cut backs, and continuity between scenes, but also in main stage action with back projection on to the back cloth, and front projection on to a gauze, while the actors continued to function in between.

The manner in which Fagan's paper was quoted on such occasions as these testified to the value of that paper, and now his prophecy of the electrician "as an artist seated at his switchboard as a player at an organ" had come to pass in reality. The light console was really important, but probably the theatre would ignore it, as usual, and leave it to the cinema! Finally, Mr. Ridge referred to salaries and wages, and expressed the view that £500 per annum is not too much to pay a master electrician in a modern theatre, considering the large and complex plant of which he had charge. If the master electrician was to be considered an artist as well, then he must control the lighting himself at the switchboard instead of leaving the switchboard to a junior. Such a man must be properly paid.

Mr. GILLESPIE WILLIAMS, remarking on the enormous task the author had undertaken in attempting practically a history of stage illumination, said there were one or two points in the history as set out in the paper with which he did not altogether agree. For instance, in connection with the lighting of the cyclorama, the author had only mentioned two names from 1917 onwards. It was pointed out that Volk's experiments were with a model stage, using a specially coloured screen, and presumably this did not materialise into a commercial and practical installation. Had anything more been done in that connection? Ridge, between 1926 and 1928, made some interesting experiments with red, green and blue at the Festival Theatre, but it was not until 1931 that he carried out his first cyclorama installation in this country at Halifax, employing red, green, and blue. Prior to that, however, Mr. Williams happened to know of an installation in Swansea in 1928, in which the cyclorama was illuminated by red, green, and blue, and a great deal of noise was made in the Press about it. The author also stated that the development of cyclorama lighting on the three-colour process was held up because the ordinary commercial wire dimmer did not meet the demands of colour mixing, and that it was not until a special dimmer was designed—again for the Halifax Theatre, in 1931—that cyclorama lighting on the three-colour process was practicable. For years before that, however, radial stud dimmers were used with every satisfaction. Looking up some notes, he found a reference to the use of this dimmer at Richmond some time before 1931, which gave practically the same results as the special design mentioned. Again, the list of cyclorama installations mentioned in the paper was not complete. There were a good many that were not mentioned.

On the question of automatic controllers, Mr. Williams said it would have been interesting if the author had dealt with these more in detail. There was one control which had not been described but which some people regarded as important in its effect on stage illumination. (The author showed a slide illustrating this device.)

Mr. F. P. BENTHAM said there were several things which the paper emphasised and which must be borne in mind in connection with the development of stage illumination. We apparently had apparatus which gave ten times more light than was formerly the case and switchboards of various sorts for the control of that light. The question was what should be done with these means of improved illumination? Stage producers decried the use of too much light on the stage because they believed it detracted from the actors and, to a large extent, that was perfectly true. At the moment, at all events, we could not expect to have all these weird and wonderful effects for their own sake, and it was essential to subdue them and use them as an accompaniment to the actors. That being so, it would almost seem that a definite limit was placed upon activities regarding stage illumination. If that

proved to be the case, then surely stage lighting would have to branch out on its own, so to speak, and how could that come about? There were several ideas behind that suggestion. Young people sometimes dreamed rather wild things, and perhaps he was one of those people. We were hearing of all sorts of gadgets for producing marvellous effects in stage illumination, and it did not seem an impossibility to him to provide a show by the aid of lighting alone. Indeed, it seemed to him that stage lighting must develop until it became a great attraction in itself, and it was not inconceivable that in less than fifty years at any rate there would be a show in which music and stage illumination would play the parts and there would be no actors at all. The stage lighting would be related to the music which would be real "Music-drama." The realisation of Wagner's ideal. That surely was something to aim for in stage lighting.

Mr. BENNETT remarked that there is one aspect of stage lighting which presents some difficulty and is still in its infancy, viz., front-of-house lighting, upon which it would be interesting to hear the author's views. There seemed to be six methods of installing front-of-house lighting. There was lighting from the side of the proscenium, which was to be seen at the Adelphi in London and could be man operated. There were ceiling spots over the orchestra, as in the Opera House at Charlottenburg, which are operated by remote control. In the Atrium Cinema in Berlin, and in the Roxy Theatre in New York, there are lights near the centre of the auditorium which are hand operated from a platform, and in the latter there are lights operated from the back of the auditorium. In the Davis Theatre at Croydon front-of-house lighting could be operated from the bioscope box between the first and second circles, and there were various remote control positions, as, for example, in front of the first circle at the Saville Theatre in London and in front of the second circle at the Oxford Theatre. It was obvious, therefore, that stage-lighting experts, architects, and stage producers were experimenting with an enormous number of positions for front-of-house lighting in order to give the minimum of interference to the audience, and also the minimum interference with the architectural features of the theatre. There was still, however, a considerable body of producers who hold the view that any type of front-of-house lighting destroys the illusion of the stage by showing up the means by which the illusion is produced, and he would like the author's views as to the best position for lights for front-of-house lighting.

Mr. HAROLD BRIGHT asked how any form of front-of-house lighting could be reconciled with cyclorama or projected scenery of any kind. Footlights or lighting from the sides seemed to him the only possible alternatives, as any form of shadow on the cyclorama was quite inadmissible. Referring to the reactance dimmer, Mr. Bright asked for further information from the author, adding that it seemed to him that, with the fairly general use of alternating current nowadays, this type of dimmer should come into its own more than it had done hitherto owing to the higher efficiency obtained with it.

Mr. L. G. APPLEBEE, in the course of his reply to the discussion, said he could not give Mr. Ridge any help with regard to glass. He and his business associates had tried all over the world to obtain glass which would serve for colour mixing, in order to avoid the use of those hateful gelatins, but without success. If only glass coloured in the desired shades could be obtained, many troubles would be overcome. Frankly, however, he feared that the use of glass for this purpose was as far off as ever. Apart from the question of colour, the difficulty with glass was that it did not give the effect of "life" that was obtainable when gelatin was used—for example, it did not make an old piece of canvas look like velour or tapestry, as was the case with gelatin. His experience had been that glass gives a "wishy-washy" effect. Again, if one went to a glass manufacturer's works, it was usually found that some of the so-called standard glass differed considerably in colour at the two edges of a sheet. He had tried Czecho-Slovakia and the Continent generally, as well as America and this country, but without success.

Commenting on Mr. Ridge's remark that he had nothing to do with the Covent Garden scheme, the author said that was not altogether the case. Ridge and Aldred had produced a formula for a cyclorama dimmer, and all the dimmers on the board at Covent Garden were made to that formula. It might be a slight satisfaction to Mr. Ridge to know that this was so. Continuing, the author said he entirely agreed with what Mr. Ridge had said with regard to salaries, because he felt at the present time that the standard was being let down. He himself represented the third generation in theatre lighting—although he was not attached to any particular theatre—and the first two generations were not only expected to maintain the electrical equipment of the theatre, but also to light the scene before the producer came on the job. The producer then possibly made some alterations. The tendency to-day, however—although not perhaps in the bigger West End theatres where the standard was being maintained—in those theatres which were dropping down was continually to cut salaries. Hence, apart from the artistic side, maintenance suffered—i.e., expensive apparatus was being installed, but it was not being maintained as it should be.

In reply to the remarks of Mr. Williams on cyclorama lighting, the author said he was glad to hear that there had been an instance before the earliest mentioned in the paper, but he must remind Mr. Williams that Perier first used the method in 1913 in America. It was quite true, also, that the list of installations mentioned in the paper was not complete. It was not intended to be. A few examples had been picked out impartially, irrespective of who had carried out the work, and he thought he could say he had religiously kept to that principle throughout the paper. The most successful ones had been mentioned, but there were others. So far as automatic boards were concerned, he had stated in the paper that they were not applicable to the legitimate stage, and he still maintained that view. The cinema was another matter, but, so far as the legitimate stage was concerned, he would like to place Mr. Williams with an automatic board in the middle of one of Mr. Cochran's revues; Mr. Williams would then quickly realise that the finest automatic board ever made would not do for that kind of show. As to dimmers, he spoke from years of experience, and maintained that the formula devised by Messrs. Ridge and Aldred is the right and correct one, and the best so far for cyclorama colour mixing.

As to Mr. Bentham, the author said it was always refreshing to find a youth who was keen, and seeking for something entirely different. He had to spend a great deal of time with Mr. Bentham, and he enjoyed it very much. Undoubtedly there was something in the suggestion that light might become an entertainment by itself, but, personally, he did not think it would be so on the legitimate stage. It might have an application in the cinema and the concert hall, in conjunction with a symphony orchestra, but even then its success would depend upon it being operated by a man adequately paid, and contingent also on the man being an artist.

Replying to Mr. Bennett on the question of front-of-house lighting, the author said the ideal place was the second circle, and the architect should design his theatre with sight lines which would allow of this being done. If the circle was not of the right

height, however, the "spots" would strike the back walls or the cyclorama. With this front-of-house lighting it was necessary to arrange for ventilation, and it should preferably be forced ventilation. There might be some difficulty with the mobile arcs, and it might be necessary to arrange to have a spot light strike some 12 ft. up the back-cloth. A special space would have to be provided for these arcs, as it must definitely be concealed where the noise of the spluttering arc and the frantic telephone instructions of the stage producer could not be heard by the audience. There was a very good arrangement in this connection at the Shakespeare Memorial Theatre, but the results obtained at the Adelphi were not very good, because the lamps were in such a position that they could only reach one side of the stage, and not the whole of it together. The ideal position for the mobile lamp was one from which any part of the stage could be reached, and in the modern theatre the bioscope room was the best position. The higher up it was, the better, because then the shadow was shorter.

# The Illuminating Engineering Society's Annual Dinner

(Held at the Trocadero Restaurant, Piccadilly Circus, London, W., at 7.30 p.m. on Tuesday, February 5th, 1935)

*Photo by "Rawood," Ltd.*

This photograph was taken during the dinner without the aid of flashlight. In the background The President (Mr. H. Hepworth Thompson) is seen standing. On his right is the Rt. Hon. W. Ormsby Gore, M.P. (First Commissioner of Works); on his left Professor W. M. Thornton (President of the Institution of Electrical Engineers), Sir Frank Smith and Lady Smith, Mr. Maurice E. Webb and others.

Last month the Illuminating Engineering Society once more held its Annual Dinner at the Trocadero Restaurant (Piccadilly Circus). At this gathering which took place on February 5, history repeated itself. The attendance (272 according to the Table Plan) exceeded by about forty more that for the previous year, so that all previous records were beaten once again.

The President (Mr. H. Hepworth Thompson) and Mrs. Thompson received the guests. This year the Society was honoured by the presence, as principal guest, of the Right Honourable W. Ormsby Gore, M.P., First Commissioner of Works, who proposed the toast of the evening. Others present included: Mr. Hubert Baines (Chief Engineer, H.M. Office of Works) and Mrs. Baines, Mr. C. Valon Bennett (President of the Institution of Gas Engineers) and Mrs. C. Valon Bennett, Mr. A. W. Beuttell (Vice President), Mr. G. Campbell and Mrs. Campbell, Mr. J. G. Clark, Major F. C. Cook (Chairman of the Departmental Committee on Street Lighting, Ministry of Transport), Col. A. E. Davidson (President Designate of the Institution of Mechanical Engineers) and Mrs. Davidson, Mr. J. S. Dow (Hon. Secretary) and Miss M. Dow, Mr. R. S. Downe and Miss Downe, Mr. J. Eck and Mrs. Eck, Lt.-Col. Kenelm Edgecumbe (Past President), Col C. H. Silvester Evans and Mrs. Silvester Evans, Mr. Alex. Forbes (President of the Association of Public Lighting Engineers) and Mrs. Forbes, Dr. H. F. Gillbe (Secretary of the Departmental Committee on Street Lighting, Ministry of Transport), Mr. Percy Good (Hon. Treasurer) and Mrs. Good, Sir Francis Goodenough (Past President) and Lady Goodenough, Dr. N. A. Halbertsma, Miss C. Haslett, Mr. Stephen Lacey and Mrs. Lacey, Mr. C. A. Masterman and Mrs. Masterman, Mr. C. C. Paterson (Past President) and Mrs. Paterson, Mr. F. W. Purse, Mrs. Purse, and Miss Purse, Mr. W. R. Rawlings and Mrs. Rawlings, Mr. T. E. Ritchie and Mrs. Ritchie, Mr. E. M. Severn and Mrs. Severn, Sir Frank Smith (Secretary of the Department of Scientific and Industrial Research) and Lady Smith, Professor W. M. Thornton (President of the Institution of Electrical Engineers), Mr. L. J. Veit and Mrs. Veit, Mr. Maurice Webb (Vice President of the Royal Institute of British Architects), Mr. C. I. Winstone and Mrs. Winstone, Mr. T. Young and Mrs. Young.

As usual practically every place available was filled, one of the very few absentees being Mr. S. B. Langlands, whom an attack of influenza (from which we learn with pleasure he has now recovered) prevented from travelling down from Glasgow.

## "THE ILLUMINATING ENGINEERING SOCIETY"

The usual loyal toast having been duly honoured, the toast of "The Illuminating Engineering Society" was proposed by THE RT. HON. W. ORMSBY GORE, M.P. (First Commissioner of Works). After expressing his pleasure at being present Mr. Ormsby Gore remarked that as First Commissioner of Works he had been brought into close touch with many different aspects of the Society's work. No one could have failed to be impressed by the progressive attitude of those responsible for the lighting of homes and offices, of public places and thoroughfares in recent years.

He wished to say a few words on certain branches of the subject with which he and his Department were specially concerned. The first of these, in view of the near approach of Their Majesties' Jubilee, was the floodlighting of public buildings and gardens. It was a great pleasure to have this opportunity to acknowledge publicly the ready generosity and untiring patience shown by the great lighting firms, both equipment manufacturers and supply companies, who had come forward and undertaken the lighting of so many of our public buildings entirely at their own expense. He and his Department owed a great debt to them and to the members of their staffs who have spared no trouble to make this new venture a success.

Floodlighting was still in its infancy. It would be readily agreed that they had still a great deal to learn about it. It was now known, for instance, that certain methods of lighting brought out the architectural features more effectively than other methods, and that there was very much more in this than the mere flooding of a facade or a garden with intense light. Direction, reflection, intensity, and colour all had to be carefully considered. Like all innovations, floodlighting had been severely criticised, often merely because it was new. He had been recently considering the possibility of lighting the roof of Westminster Hall so that the finest medieval timber roof in the world could be seen and admired even on a gloomy day. He felt very strongly then that we must be exceedingly careful as to the way in which we used this new lighting in such a place, but he was hopeful that some scheme could be devised for this building which would play an important part in the Jubilee celebrations. Increase in knowledge was facilitating the solution of such difficult problems as these, and the application of the light in such a way that there was no feeling of incongruity.

For—and in spite of the critics—he felt that floodlighting was going to develop, and to play an increasing part, particularly in times of national celebration and thanksgiving. It was not inappropriate that our historic public buildings, which had watched unobtrusively over so many of our national vicissitudes, should share in our celebrations. There was another very strong argument for floodlighting—people have more time to look at buildings in the evenings, and floodlighting enabled them to do so. People, too, noticed a fine building and its architectural design as it stood out against the night. Further, the very fact that floodlighting was only carried out on special occasions added to its effectiveness and usefulness in raising public taste. He hoped that in this sphere the happy co-operation between his Department and members of the Society might be continued and extended on various occasions.

Another form of lighting which presented its own special problems was the lighting of our picture galleries and museums. His Department has just completed a new installation of electric lighting at Trafalgar Square. Three years had elapsed since a committee was appointed by the Director and Trustees of the National Gallery to lay down the principles governing the new lighting of the galleries at Trafalgar Square. The first was, of course, the adequate illumination of the pictures, and the second a minimum amount of light on the floor and upper portion of the ceiling in order to reduce the effects of reflection of spectators and other objects in the glass of the pictures. By this contrast effect, and also by using opaque masks and shades, it had been found possible to light the pictures adequately without using very powerful lamps, and so to reduce dazzle.

Another fascinating side to the lighting of picture galleries was the question of lighting and colour Much remained to be done before the pictures in our galleries could be visited at any time of the day and seen in their true colouring, in spite of the vagaries of natural lighting. He looked forward with great interest to the experimental opening of the National Gallery on March 8. He hoped that soon afterwards the Gallery would be opened to the general public on certain evenings each week, so that its wonderful contents might be viewed by artificial light.

These, however, were the by-ways of lighting. The main work of the Society lay in other fields, in the lighting of homes, and buildings, and public places. It was difficult to estimate too highly the benefits gained in health and safety, and the more pleasant and efficient regulation of our common life, from the great improvement in lighting for general use. These benefits might be far greater if the public generally were more alive to the serious effects of inefficient and unsuitable lighting. The Society had a great work to do in educating the public in these questions and in making them realise the loss of time in industry, the detriment to health due to unconscious eye strain, and the inefficiency and irritation due to inconvenience which, through long custom, pass unnoticed.

He would like to persuade every manufacturer in the country to visit the Home Office Industrial Museum and see for himself the striking proofs and illustrations of the difference which good lighting can make in the factory. He would realise that modern lighting is not a luxury, but a sound investment, even from the purely commercial standpoint, often resulting in savings in time and an increase in efficiency which very soon pay for the initial expenditure. He would see how his factory or warehouse can be made a bright and cheerful place instead of a hall of Stygian gloom, with dark corners and frequent accidents. He would see how certain special kinds of lighting can be used to show up the grains of woods and the weave of materials, how artificial daylight lighting will make the sorting of colours and shade so much easier; he would realise how much faster machinery seems to be travelling in poor light, and how, consequently, the risk of accidents is increased, and he would come away convinced that good lighting has an immense psychological value in increasing the cheerfulness and, incidentally, the health and efficiency of the workers.

He understood that the Society was taking an active part in connection with the Ministry of Transport Committee, which was examining the question of more efficient and uniform street lighting, and the convenience and safety of traffic, and that the Society's action in putting forward the views of the illuminating engineering profession on these questions had already been most helpful. As they all knew, the increasing volume of traffic, and, in particular, night traffic, had unfortunately not been accompanied by a corresponding improvement in lighting. This might have been due at least in part to the fact that street lighting had not until recently been regarded as falling within the province of any central organisation or authority, though the British Standards Institution had done valuable work in the preparation of a street lighting specification. The appointment of the Ministry of Transport Committee last year marked, therefore, a great step forward, and he hoped that its efforts would result in a very much improved and more uniform standard than existed at present. It might well be that better and more scientific lighting, both

from street lamps and the vehicle lamps, would do something to diminish the present still appalling toll of the road.

The basic science of illumination was physics, and in recent years physicists and biologists had begun to bridge the hinterland between them. The new science of biophysics had already achieved remarkable results in light therapy. The harmful or healing rays at either end of the visible spectrum had been studied and utilised in connection with the prevention and cure of certain diseases. But the effects of light were not limited in the human frame to the effects we perceived by our retinas. Anyone as familiar as he himself was with life in the tropics knew something of the effects of the radiation of the equatorial sun through even opaque substances, like corrugated iron. The whole phenomenon of sunstroke is indicative of lines of fundamental research which physicists and biologists must pursue together, and out of which may come further progress in the right use of artificial lights of selected wavelengths.

He was glad of the opportunity of taking them into this scientific field, because he had always held that the price of progress was the better recognition of the work of fundamental research by men of science free to strive after knowledge for its own sake. The public was delighted to honour the successful caterer to its material needs, but was all too apt to forget that behind the captain of industry and the skill of the operative was the brain of the scientist, without whom there could be neither profit nor wages, nor the greater satisfaction of human needs.

He was glad to learn that the membership of the Society was steadily growing, and he hoped that the Society would continue to prosper and to extend the work to which it had set its hand.

Mr. H. Hepworth Thompson, President, in replying, prefaced his response by a few words of apology for the crowded state of the tables and rooms, and of congratulation that such a state was necessary! These dinners were becoming more popular each year, and each year for the last five had broken a record. Although last year's was largely in excess of the previous one, a limit of 250 had appeared to be a safe estimate; but, as a matter of fact, he understood that about 270 were present.

With the breaking of such records behind them, they would next year make provision for 300, and take in another room, which would provide for a year or two to come.

The President then expressed his consciousness of the privilege of conveying to Mr. Ormsby Gore the warm thanks of the Society for the gracious way in which he had proposed this toast. The appreciation which he had expressed for the work of the Society in the direction of better and more scientific lighting should, he felt—he was sure that all present would agree—be coupled with the members of the Council and their very competent Secretary, whose work and interest was almost irreplaceable.

He was given to understand that he had at least one thing in common with the proposer of the toast, in that neither of them were "technically minded." So far as the members of the Society were concerned, they must regret this absence in their President, in view of the scientific nature of their work—but any deficiency of this nature did not hinder him from an ambitious view of the Society's future. He visualised the day, not far distant, when the Society would speak with one voice as representative of all branches of illumination, and it would be the only body to be consulted on all matters appertaining thereto.

Light, whatever form it takes, was such an important feature of our daily life, that a definite lead was required in the solution of its problems. As an example of this he referred to the Home Office Committee's recommendations of some years back on the subject of a statutory requirement of adequate illumination for workshops and factories. Nothing further had been done since, and he stressed the need for a mean standard of illumination to be specified for such places. That this want was obvious was illustrated in a recent paper read before the Society, wherein it was pointed out that in some places at least the lighting varied from a negligible factor to 20-foot candles.

If accidents, bad eyesight, and bad workmanship were to be avoided, it was imperative that some standard be adopted. Representations have been made and evidence given through the Council before the Committee instituted by the Minister of Transport. Here again he stressed the need emphasised before that Committee, of the lighting of arterial roads, for they must all deplore the appalling list of accidents daily occurring, for which by the lack of proper lighting on such roads was in part responsible.

One of the members of the Society had recently pointed out that if the height of Mount Everest be taken as a measure of good illumination, then the minimum specified by the highest class standard specification would be shown by a molehill; and following the same line of argument the illumination in our badly lighted streets by a worm cast.

In the light of these comparisons, was there anything to wonder at in the number of accidents? But in the near future road lighting might well be so improved as to render unnecessary the head lamps of the motorist.

They had all been glad to learn that the Right Honourable Gentleman had been successful in completing his arrangements for the flood lighting of our principal buildings in honour of the King's Silver Jubilee, the services of members were at his disposal if occasion arises. He would conclude by again thanking Mr. Ormsby Gore in the name of the Society alike for his presence and for his eloquent address.

## "THE GUESTS"

Mr. C. C. Paterson (Past President), in proposing the toast of "The Guests," mentioned that this task had originally been entrusted to Mr. S. B. Langlands who, however, was unfortunately unable to travel up from Glasgow owing to indisposition. Therefore, he had been asked to deputise. This loss of Mr. Langlands was his (Mr. Paterson's) gain. For it was not often that it fell to one's lot to propose the health of a Cabinet Minister—and still less frequently to do so in all sincerity, as in the present instance. He was sure that all present realised how very fortunate the Society had been in the presence of Mr. Ormsby Gore as its guest.

The toast was coupled with the names of the Presidents of the Institutions of Gas and Electrical Engineers, whose presence on such occasions was traditional. He supposed that there never was a time when gas and electricity were so necessary as to-day, nor when commercial rivalry and the art of salesmanship were so closely studied in this connection. The Society afforded a platform where those interested in both methods of lighting could meet, and in this and other ways illustrated its belief in co-operation as an essential in the study of illumination. Amongst others present Mr. Paterson mentioned Mr. Alex. Forbes, the President of the Association of Public Lighting Engineers, whose hospitality in Aberdeen some of them had recently been enjoying; Mr. Maurice Webb, Vice-President of the R.I.B.A., and Colonel A. E. Davidson, representing the Institution of Mechanical Engineers, whose hospitality the Society enjoyed for its monthly meetings. He also expressed the pleasure of the Society in welcoming Major F. C. Cook and others associated with the M.O.T. Departmental Committee on Public Lighting, Sir Frank Smith, Secretary of the Department of Scientific and Industrial Research, and Mr. Hubert Baines, Chief Engineer of H.M. Office of Works. In

conclusion Mr. Paterson welcomed Dr. N. A. Halbertsma, of Holland, who he hoped would say a few words.

Mr. C. VALON BENNETT, President of the Institution of Gas Engineers, expressed his pleasure at being present. He understood that his remarks were to be brief, as the best part of the evening—the dancing—was still to come! He observed that the President of the Institution of Electrical Engineers was to follow him. He could assure him that he would say nothing provocative! Gas and electricity, it was true, were in competition, but they had also much in common, and made use of each other's products. For the rest gas, the original illuminant, was to-day responsible for the lighting of millions of homes, factories, and shops and thousands of miles of streets. The aims of the Society were admirable. It was possible that the man in the street did not properly appreciate the value of its work, which was of world-wide interest. He felt sure that the gas industry would do everything in its power to help these efforts and to make them known throughout the length and breadth of the land.

Professor W. M. THORNTON (President of the Institution of Electrical Engineers) remarked that electric light, which he had the honour to represent, was the oldest thing in the world—or before the world! When one read in Genesis that "there was light," it was, of course, electric light; for *all* light, where made directly by electricity or indirectly by their friends in the gas industry, was, as they knew, electric in nature. Illumination had developed enormously during the last ten years. He was glad to learn that the lighting of picture galleries was receiving attention—as was essential if they were to retain their place as attractions for the masses of the people and not merely as rather sombre historical monuments. There was, however, another place that asked for help—try a cry from the depths of the earth—namely, the coal mine. The prevention of danger and of the singular disease nystagmus depended greatly on good illumination, and the coal face was, perhaps, the most difficult of all places in the world to light properly.

The general standard of interior lighting was, however, already much improved. The time might be approaching when it would be difficult to say whether it was night or day—possibly in 100 years' time this might even apply in the streets—a condition incredible to men of a past generation!

Dr. N. A. HALBERTSMA (Holland) briefly expressed his pleasure in being present and reviving memories of 1931. He was the bearer of a message of good wishes from the Dutch Illuminating Engineering Society. He hoped that the Illuminating Engineering Society would continue to flourish, and that the attendance at the next annual dinner would again be a record.

The remainder of the evening was as usual devoted to dancing and social intercourse, and proved quite as enjoyable as on similar occasions in the past. A novelty, introduced for the first time, was "Eric Ross's Dazzle" Cabaret entertainment, which was given as an interlude to the dancing during the latter part of the evening.

# Literature on Lighting

## (Abstracts of Recent Articles on Illumination and Photometry in the Technical Press)

*(Continued from page 45, February, 1935)*

### II.—PHOTOMETRY.

**72. Photo-Electric Cells.**

*R. Pochon.* Lux, p. 1, January, 1935.

A description of various types of photo-electric cells, of the alkali metal and selenium type. Curves showing response to illumination and selective effect throughout the spectrum are presented. J. S. D.

**73. A New Reflectometer.**

*Gen. El. Rev.* 38, January, 1935, p. 53.

In the course of a Survey of Developments in the Electrical Industry (Instruments) a description and illustration are given of a reflectometer to give accurate measurements of the coefficient of reflection of both specular and matt surfaces. G. H. W.

### III.—SOURCES OF LIGHT.

**74. Studies of the Gaseous Discharge Lamp.**

*T. Harada.* Jour. Jap. Illum. Engin. Soc., Vol 18, p. 257, December, 1934.

Particulars of the performances of electric discharge lamps utilising sodium and mercury vapour are given. A combination unit, comprising mercury and tungsten filament lamp to give an effect resembling daylight, is described. J. S. D.

**75. Luminous Discharge Lamps.**

*C. C. Paterson.* Elect. 114, p. 98, January 25, 1935.

The progress made during 1934 in luminous discharge lamps and their utilisation is dealt with in detail. Recent luminous efficiency figures are included. C. A. M.

**76. The Economic Value of Gas Lighting.**

*Gas Times.* January 5, 1935.

An extract from a recent paper by W. Schweder (Magdeburg). J. G. C.

**77. Gas Lighting in America.**

*Gas Times,* December 15, 1934.

Developments in the United States are surveyed and reference is made to a proposed installation on the seven-mile bridge between San Francisco and Oakland, California, now being built. J. G. C.

### IV.—LIGHTING EQUIPMENT.

**78. Vitreous Enamelled Steel Reflectors for Electric Lighting.**

British Standard Specification, No. 232, 1935.

The specification covers nine sizes of reflectors of the open dispersive type, suitable for lamps of from 40 to 1,500 watts. Precise dimensions are given and methods of testing are explained. Luminous output must not be less than 60 per cent. of that given by the lamp alone. An angle of cut-off of not less than 20° is prescribed. J. S. D.

**79. The Classification of Luminaires.**

*Z. Yamauti and Hisano.* Jour. Jap. Illum. Eng. Soc., Vol. 18, p. 240, December, 1934.

The authors approve the method of classification recommended at the I.I.C. (1931). Other methods are discussed. Ultimately a new basis, with main and secondary classifications, is outlined. J. S. D.

**80. Illumination of Structural Glass.**

*C. S. Woodside.* Am. Illum. Eng. Soc., Trans. XXIX., pp. 878-894, December, 1934.

A paper summarising the characteristics of structural

glassware with special reference to insulation, obscuration, and diffusion. The problems encountered in illuminating this glassware are discussed in a general manner. G. H. W.

## V.—APPLICATIONS OF LIGHT.

**81. Progress and Development during 1934.**
*H. W. Richardson.* G.E.C. Journal, VI., pp. 3-5 and pp. 25-35, February, 1935.

A comprehensive survey of recent progress is given. Improvements in hot cathode and tungsten lamps are dealt with, together with their utilisation in street lighting, industrial lighting, aerodrome lighting, interior lighting, etc. Numerous photographs of recent installations of all types are given. C. A. M.

**82. Annual Review of Developments in 1934.**
Gen. El. Rev., 38, pp. 57, 62, January, 1935.

Developments and improvements in lighting during 1934 are given with illustrations. G. H. W.

**83. Daylight Illumination.**
*M. Cohu.* Lux, October and November, 1934; January, 1935.

A series of articles discussing daylight and the calculation of natural illumination in interiors. J. S. D.

**84. Architectural Lighting.**
L'Illuminazione Razionale, VII., p. 230, January, 1935.

Striking examples of "architectural lighting" by means of extensive areas of diffusing glass are illustrated, and specimens of some modern forms of fittings combining luminous tubes and metal embellishment are portrayed. J. S. D.

**85. Light and Architecture.**
*A. L. Powell and others.* Am. Illum. Eng. Soc., Trans. XXIX., pp. 821-834, December, 1934.

A description of the exhibition of contemporary American industrial art at the Metropolitan Museum of Art, New York City, with special reference to lighting arrangements. Photographs and descriptions are also given of the lighting of eight business houses. G. H. W.

**86. Light and Architecture.**
*L. G. Cook and others.* Am. Illum. Eng. Soc., Trans. XXX., pp. 19-30, January, 1935.

Modern store lighting is reviewed and photographs of seven installations given. G. H. W.

**87. The New in Lighting.**
*C. McL. Moss.* El. Journal, Vol. 32, No. 1, p. 23, January, 1935.

An account, with illustrations, of some of the modern tendencies in lighting practice. W. R. S.

**88. A Novel Lighting Installation.**
*S. H. Kahn.* El. Review, CXVI., No. 2,982, p. 81, January 18, 1935.

A brief account, with photographs, of the special lighting used for a house in Paris. W. R. S.

**89. Industrial and School Lighting.**
*H. B. Dates.* Am. Illum. Eng. Soc. Trans., XXIX., pp. 866-877, December, 1934.

A survey of the work done during 1934 to improve lighting conditions in factories, schools, and colleges. Stress is laid on the psychological effect of improved lighting in schools, and some interesting results are given. G. H. W.

**90. Sight Saving Classes for Defective Children.**
*S. Nakao.* Jour. Jap. Illum. Eng. Soc., Vol. 19, p. 7, January, 1935.

The influence of conditions of illumination on vision are stressed, and recommendations on the lighting of classrooms are made. Special classes for children having defective eyesight are recommended. J. S. D.

**91. Lighting an Indoor Cricket School.**
Gas Journal, January 16, 1935.

An illustrated account of the lighting by gas of an indoor cricket school at Colchester. J. G. C.

**92. Street Lighting and the Science of Seeing.**
*Paul H. Goodell.* Am. Illum. Eng. Soc., Trans. XXX., pp. 49-88, January, 1935.

A paper, followed by a discussion, emphasising the need for better street-lighting in America. The advantages of fixed street-lighting over motor-car headlights are discussed, and the "Science of Seeing" applied to discover the factors which will give the most beneficial lighting system. G. H. W.

**93. Rationalisation of Public Lighting in City Planning.**
Report by Street Lighting Committee, Jour. Jap. Illum. Eng. Soc., Vol. 19, p. 12, January, 1935.

Embodies results of the study of street lighting and traffic in Tokio in 1933. Rules dealing with (a) public lighting in general, (b) lighting of trade centres, etc., and (c) floodlighting of public buildings are recommended. J. S. D.

**94. Experimental Street Lighting.**
Gas Journal, November 21, 1934.

Illustrates the lighting of an avenue by gas lamps devised to illustrate the various ways in which gas can be applied to street lighting. J. G. C.

**95. Public Safety as Affected by Street Lighting.**
*R. E. Simpson.* Am. Illum. Eng. Soc., Trans. XXX., pp. 31-48, January, 1935.

A paper summarising work undertaken by the National Bureau of Casualty and Surety Underwriters to find the relation between frequency of traffic accidents and street illumination. G. H. W.

**96. Code of Street Lighting.**
Am. Illum. Eng. Soc., Trans. XXX., pp. 96-116, January, 1935.

A report prepared by the Street Lighting Committee of the American I.E.S., giving recommended mounting heights, spacings, and land lumen output for various types of street. G. H. W.

**97. Public Lighting with Gas.**
*W. J. G. Davey.* Gas Times, November 24, 1934; February 2, 16, 1935.

A series of articles discussing public lighting by gas and showing how values of illumination may be calculated. J. G. C.

**98. Road Surface Reflection, Characteristics, and Their Influence on Street Lighting Practice.**
*J. M. Waldram.*

A translation into French of the above paper read by the author before the Association of Public Lighting Engineers. W. R. S.

**99. Church Lighting with Gas.**
Gas Jour., January 2; Gas World, February 9; Gas Jour., February 13, 1935.

Describes the lighting with gas of (a) St. Mary's Church, Harlow, (b) St. Martin's Church, Horsley, and (c) West Wickham Parish Church. J. G. C.

**100. Mountainside Quarry Illuminated.**
*Francis A. Westbrook.* El. World, 105, p. 206, January 19, 1935.

A short description is given of a quarry-lighting installation in New Hampshire, U.S.A. S. S. B.

**101. Floodlighting.**
*Anon.* Elect., 114, p. 97, January 25, 1935.

A number of photographs are given showing floodlighting schemes carried out during the Royal visit to Melbourne and Adelaide. C. A. M.

**102. Floodlighting with Gas.**
Gas Times, December 22, 1933; Gas Jour., January 30, 1935; Gas World, February 2, 1935.

These three articles illustrate recent installations of floodlighting with gas at (a) the Alexandra Palace, (b) the old Cloth Hall, Newbury, and (c) the Pump Room at Leamington Spa. J. G. C.

**103. Jubilee Illuminations.**
*Anon.* El. Times, 87, p. 111, January 24, 1935; 87, p. 143, January 31, 1935.

Photographs and description of various fittings appropriate to the Jubilee Celebrations. W. R. S.

## Glare Frequency Data

(Mr. R. W. Daniel has kindly furnished us with the following explanation of the "Glare Frequency" Table which appeared in his recent paper on Industrial Lighting (*Illum. Eng.*, Jan.1935, p. 9). The method adopted will no doubt be of considerable interest to readers concerned with industrial lighting).

The Glare Frequency Table was obtained as follows. Glare was divided into three degrees of severity:—

(G.1).—*Some Glare*, as from 40 or 60 watt pearl lamps or equivalent, partly screened and/or against a light background.

(G.2).—*Bad Glare*, as from 60-100 watt pearl lamps unscreened and/or at closer range than above. Medium Colour Background.

(G.3).—*Very Bad Glare*, from clear or gasfilled lamps unscreened, at close range, and against dark background.

Photometric readings were usually taken in sets, i.e., a series of readings along a particular work bench or at each of a number of similar and similarly lit machines. Where possible each such set of photometric readings was broadly placed in one of the three glare severity grades.

Thus, supposing fifty sets of photometric readings were taken at fifty different benches where buffing or silverware was carried on. Assume that *eight* were free from glare, *thirty* were in category G.1, *eight* in category G.2 and *four* in category G.3. Converting to percentage basis the result appears in the glare severity table as:—

| | Free from Glare. | Glare Severity. | | | |
|---|---|---|---|---|---|
| | | G.1 | G.2 | G.3 | per cent. |
| Buffing ... | 16 | 60 | 16 | 8 | |

The results are very approximate since they are based only on visual observation, within very broad limits; but they do show the general tendency in a given process.

## Factory Accidents: Their Prevalence, Distribution and Causation

In his Shaw Lecture, delivered before the Royal Society of Arts on February 25, Mr. D. R. Wilson (H.M. Chief Inspector of Factories) pointed out—what is, perhaps, not generally realised—that the total of industrial accidents in this country (342,095 for 1928) is approximately twice the number of accidents reported in streets, though the converse holds good for fatal accidents. The annual compensation paid on account of accidents, approximately £2,000,000 for factory occupations, is a very substantial sum, and there is every inducement to try to reduce the number of accidents that occur. The figures in terms of fatal accidents per 100,000 persons employed illustrate that certain industries (shipbuilding, chemical, generation of electricity, etc.) are relatively the more dangerous, though coal mining is admittedly the most dangerous of all. Tables of Causation bring out the preponderance of accidents due to two causes, shafting and gassing. Inexperience is undoubtedly a contributing factor, and hours of work, periods of relaxation, etc., also have an influence. Self-protection on the part of the worker is inherently dependent on ability to see. Figures (twenty years old, however) were quoted to show that the accident rate by artificial light may be as much as twice that prevailing in daylight. Again, in coal mining, whereas there is little variation in the number of accidents underground throughout the year, there is a consistent increase in the surface accidents during the winter months.

Fortunately there does seem ground for encouragement in the records of fatal accidents during years from 1904 onwards. The conclusion is drawn that the fatality rate has fallen from 18 to 12 per 100,000 persons employed, and it is justifiable to assume that liability to the more serious kind of accidents has diminished during the last twenty-five years.

## A Present from Western Australia

We take this opportunity of recording a kindly gift from a friend in a distant land—Mr. R. W. C. Forsythe, the only member of the Illuminating Engineering Society resident in Western Australia.

In a recent letter to Lieut.-Colonel Kenelm Edgcumbe (Past President), Mr. Forsythe explained that he was sending three gifts—an inkstand for himself, a vase for Mr. J. Wyatt Ife (until lately Hon. Treasurer of the Society), and a model lighthouse for Mr. J. S. Dow (Hon. Secretary)—all made of West Australian timber. The inkstand is made of "jam wood," an exceptionally hard material.

The model lighthouse, which is now located in the offices of the Society, at 32, Victoria-street, and the vase are made from the old "Vasse" lighthouse at Busselton (W.A.), which Mr. Forsythe demolished owing to the structure having become obsolete and unsafe. The timber is Jarrah, and was placed in position seventy-three years ago. It was cut in the first sawmill in West Australia, situated on the coast seven miles away. There are, Mr. Forsythe mentions, many historical ties between England and West Australia in the neighbourhood. In his somewhat remote spot he naturally does not have many opportunities of coming in touch with people interested in illumination, and therefore welcomes this journal, in which information of doings at home is given.

We are sure that all members of the Society and all readers of the journal will join us in expressing appreciation of Mr. Forsythe's kindly act, and in wishing him good luck.

## Illuminating Engineering Society (U.S.A.).

### Report for 1933-34

The report of the General Secretary of the Illuminating Engineering Society (U.S.A.) for the period 1933-34, which appears in the Transactions for December, 1934, affords notable evidence of recovery from the difficult period through which the Society has been passing. During the past three years severe losses in membership and revenue were recorded. In each year from 1930 onwards a progressive decrease in membership was shown. Now, for the first time, the membership curve is again pointing upwards. The total income was approximately 41,000 dollars in 1931-32, 35,000 dollars in 1932-33, and 33,000 dollars for the period just terminated. We are glad, indeed, to note that the bad times are passing, and wish the Society continued progress and renewed prosperity.

# Recent Patents

*(Abstracts of recent Patents on Illumination & Photometry.)*

**No. 419,899. "Improvements in or relating to Sidelamps or other Lamps for Motor Cars."**
*Leonard, P., September* 30, 1933.

This specification relates to vehicle lamps of the type mounted to swivel about a vertical axis. According to the specification the lamps of a pair are each spring biased and their controls are connected for common remote operation. The spring biases are in opposite directions so that their effects upon the common operating member cancel out.

**No. 420,992. "Improvements in Directional Lighting Fittings."**
*The General Electric Company, Limited, and Beggs, S. S., July* 4, 1933.

The specification describes a fitting for road lighting with a discharge tube and colour compensating lamps provided with directive devices arranged to direct from the colour compensation lamps different proportions of total light transmitted in various directions. In this manner a greater degree of colour compensation in one direction, e.g., towards a pavement, than in another direction, e.g., towards a road, is obtained.

**No. 421,462. "Improvements in Electric Incandescent Lamps."**
*The General Electric Company, Limited, September* 19, 1933 (*Convention, Germany*).

This specification relates to lamp bulbs, particularly for miners' and like battery hand lamps with alkaline batteries. In order to prevent corrosion of tin or like solder by the alkali, the leading-in wire is soldered to the cap contact by means of cadmium at a point remote from the contact face.

**No. 421,537. "Improvements in and Relating to Gas Filled Electrical Discharge Lamps and Tubes."**
*From V. C., June* 22, 1933.

According to this specification, the electrodes of a discharge tube are housed respectively in branches of the tube disposed close and parrallel to one another and the tube is bent in a curve from the electrode branches at a right or acute angle thereto and encircling them.

**No. 421.663. "Improvements in Directional Lighting Fittings."**
*The General Electric Company, Limited, Weir, W. and Wilson, G. H., August* 11, 1933.

This specification covers a street lighting fitting utilizing a horizontal linear source perpendicular to the length of the street. The fitting comprises refracting prisms at the sides of and parallel to the source with edges not appreciably longer than the source. The prisms are arranged, and, if desired, associated with reflectors, so that the polar distribution in a vertical plane containing the length of the street is disc-like.

**No. 421,705. "Improvements in or Relating to Luminous Electric Discharge Tubes."**
*Westinghouse Lamp Company, April* 29, 1933 (*Convention, U.S.A.*)

This specification relates to sodium and similar metallic vapour lamps with heated cathodes for alternating current. In order to increase the efficiency on alternating current, the current density in the lamp is controlled by utilizing two anodes of relatively large area and each sub-divided into at least two parts, the parts of any one anode being spaced apart in the envelope so that the glow discharge in each half cycle is divided into several paths.

**No. 421,783. "Improvements in and Relating to Electric Discharge Lamps."**
*The British Thomson-Houston Company Limited, June* 7, 1933 (*Convention, U.S.A.*).

This specification relates to the ignition of discharge tubes, particularly those of which the length is great as compared with the diameter. The lamp is equipped with an auxiliary starting electrode which is connected through a condenser to one of the main electrodes. The condenser and auxiliary electrode are connected to one main through an impedance for charging the condenser. The discharge of the condenser, which takes place between the main and auxiliary electrode, by a coupling to the main circuit sets up a high impulsive voltage therein and thus causes a discharge between the main electrodes.

**No. 422,386. "Improvements in or relating to Reflectors for Arc Lamps."**
*Zeiss, Ikon Aktiengesellschaft, April* 14, 1934 (*Convention, Germany*).

According to this specification a reflector arrangement for arc lamps comprises a casing, enclosing a cooling fan and its motor, which is closed at the front by a reflector and has openings for entry and exit of air at the back.

**No. 422,631. "Improvements in or relating to Gas Burners with Safety Control of Gas Supply."**
*Baker, A. H., July* 17, 1933.

According to this specification a valve governing the supply of gas to a burner, such as a pilot burner, is controlled by a thermostat, heated by the heat of the burner, and comprising a bellows structure containing an expansible liquid. On extinction of the burner the liquid cools and it and the bellows consequently contract. The gas is cut off from the burner by a valve operated by the bellows.

**No. 422,657. "Improvements in and relating to Electric Illumination Control Systems."**
*The British Thomson-Houston Company, Limited, January* 28, 1933 (Covention, U.S.A.).

This specification relates to the control of illumination systems in which provision is made for presetting a plurality of lighting scenes, and for fading one scene into another. According to the specification, the intensity of illumination of the lamps on a circuit is controlled by a system which includes a thermionic valve, with a control grid and a number of reactive circuits which control the voltage applied to the control grid. In each of the reactive circuits the reactance is adjustable to permit the presetting of the several successive illumination intensities. For fading one scene into another the reactances of the appropriate circuits may be oppositely varied. The required variation of reactance may be effected by variation of a direct current flowing through auxiliary windings upon iron cored reactances.

# The Lighting of the New Building of the Royal Institute of British Architects

Members of the Illuminating Engineering Society were afforded an opportunity of inspecting this new building and studying the original architectural design and methods of lighting on January 15th. We are indebted to Messrs. Waldo Maitland and Partners, the lighting consultants, for the technical data embodied in this article and to *The Architectural Review* for the use of the various photographs illustrating it.

## General Features of the Building.

THE plans for this new building, erected at a total cost of approximately £125,000, were chosen by open competition, 284 designs (including sixty-four from architects overseas) being submitted. The design of Mr. G. Grey Wornum, F.R.I.B.A., which was selected, is original in conception, one feature being that the building is almost entirely without corridors. The conventional conception of superimposed floors of equal height has been abandoned. Each room has height appropriate to its floor space; yet all fit easily into the rectangular mass of the whole. In spite of the great amount of daylight flooding the interior there are no light wells. From foundation to roof the building is composed entirely of Empire materials—some little known and never used in architecture before. The decorative possibilities of modern artificial lighting (for which Messrs. Waldo Maitland and partners are consultants) have been fully exploited. Special attention has been given by Mr. Hope Bagenal, the acoustic consultant, to the problems of acoustics in rooms to be used for public speaking. A feature of the interior is the liberal use of unusual sculptured and painted decorations, all the work of young men, most of them under thirty years of age. The unusual design of the building involved exceptional steel work. To carry the enormous load of the library and the offices above the large halls below without using intermediate columns as supports, two gigantic girders, each 60 feet long and 12 feet deep, and weighing thirty tons, had to be incorporated into the core of the building. Their transport and introduction into the framework of the building was a remarkable feat of engineering, which a few years ago could not have been contemplated. The automatic heating and ventilating plant housed in a large sub-basement and the special arrangements in the kitchens are also of considerable interest.

Figure 1. This shows the lighting in the Henry Florence Memorial Hall from the sills of the windows which illuminates the curtains and the lower ceiling. The lower ceiling shows the specially-designed Saucer domes with their single lamp fittings. The vertical wall at right angles to the main and lower ceiling is the reflecting surface for the white light provided by the concealed carbon dioxide tube.

## General Nature of Lighting.

The fact that the lighting of the new building was considered during the initial stages of the design is indicated by the way in which the lighting is harmoniously related to its architectural surroundings. The need for simplicity in form and treatment of the lighting throughout was the basic principle, and was considered an appropriate treatment to achieve harmony and dignity.

In most of the interiors indirect lighting was used. Large and small areas of ceiling or wall surfaces are illuminated to reflect the light, the size and brightness of the surface varying according to the special requirements of the interior. Owing to these differences of illuminated surface, the interest in the lighting is retained throughout the building, and because of the spaciousness of the building, the variation of lighting becomes more apparent, therefore a careful handling of intensities and brightnesses was necessary.

Mr. Wornum's brilliant planning of the various apartments and their relationship to one another provide a magnificent problem from the lighting point of view; therefore, it is important from this viewpoint to grasp fully the feeling of the building and visualise at the outset the spaces which are to be illuminated.

In the more important positions in the building, and where it was considered necessary, allowance was made in the design and construction of equipment and fittings for larger lamps, which would serve to increase the illumination anything from 33 1-3 to 50 per cent. Such positions include:—The Library, the Meeting Hall, the Reception Room, the Henry Florence Memorial Hall and Offices, Main Staircase, and Entrance Hall.

The electricity supply is 3-phase 230 volts A.C., and the total connected lighting load is approximately 65 kw.

### The Exterior.

There is no basement area on the Portland Place front, but in its place is a raised, paved platform, in which are set four cast glass rectangles, below which are placed the floodlights. Each reflector contains a 300-watt lamp with a silvered mirror reflector controlling the beam. The floodlighting was designed to give modelling and shadow value to the facade at night, and in effect is quite distinct from the hard and brilliant illumination usually associated with the word "floodlighting." Access to the reflectors is effected by panels in the ceiling of the basement. The total loading is 1,200 watts.

### Entrance Hall and Main Staircase.

The relatively low height of the Entrance Hall gives strength of contrast to the great height and verticality of the Main Staircase well. This emphasis is strengthened by the arrangement of the lighting which mainly illuminates the walls, tending to give the impression of greater width. The lightness of the Perrycot stone and the precast terrazzo floor slabs provide an excellent reflecting surface. A great deal of reflection from the floor and walls accounts for the comparative lightness of the ceiling. The interior is approximately 30 ft. 0 in. x 30 ft. 0 in., and is illuminated by ten 60-watt lamps in saucer domes. Provision in the design of the fitting has been made to accommodate a 100-watt. lamp.

The Main Staircase, 40 ft. high from ground floor level, is flanked by four stanchions cased in polished Ashburton marble. The main system of lighting is from twenty cast glass panels in the coffered ceiling. Twenty 60-watt lamps are used in industrial reflectors. Access for relamping and cleaning is by means of traps over each panel on the Library floor. No ventilation to the panels is provided, as it was considered unnecessary owing to the sufficiently large glass area which readily dissipates the heat. The load is 1,200 watts.

The glass balustrading is of "Armourplate" glass, and the raking balustrades bear etched designs. The bases contain tubular lamps 1 ft. 6 in. in length, each 52½ watts. The light passes through the thickness of the glass, bringing out the green and silver lines. Special arrangements are made in the metal strings, which are held in position by two screws, making removal a simple operation. There are forty-eight lamps in all, each consuming 52½ watts, with a total load of 2,520 watts.

### The Henry Florence Memorial Hall.

The chief problem in the lighting of the Henry Florence Memorial Hall was the flexibility necessary in the arrangement of the light sources, since the hall was called upon to perform diverse functions, such as exhibitions, examinations, banquets, receptions, dances. The planning of four systems of illumination differing in diffusive qualities provides the variation, and may be used separately or combined, according to which effect or intensity is desired.

The placing of the sources of light are such that illumination may be provided from walls, floor or ceilings. The fourteen panels arranged in pattern form on the main ceiling are 28 ft. from floor level. Six panels contain 60-watt lamps and eight panels contain 100-watt lamps. Access by means of floor traps on the library floor level above these units are conveniently arranged for renewing lamps and cleaning the reflecting equipment. These panel lights are to be used for examinations, and the total current consumption is 1,160 watts. On more ceremonial occasions concealed lighting in narrow slots on the sides of the main ceiling are used. This lighting is white in colour and is unusual in the effect it produces, combined with the other lighting systems employing ordinary gasfilled lamps. To achieve the effect of white light two 120-foot-long carbon dioxide tubes are used which work at a pressure of 24,000 volts, with a total consumption of 7.2 k.w. Two transformer chambers were built to house the necessary apparatus, being placed at the east end at library floor level, immediately over the ends of the slots, concealing the tubes. The large window overlooking the Main Staircase allows much of the light from the Memorial Hall to penetrate to the staircase, creating dramatic effects.

On the lower ceiling ten special saucer domes are arranged, incorporating bowl fittings. Each dome contains a 300-watt lamp, the total loading amounting to 3,000 watts.

For dances or receptions the curtains and lower ceiling are softly illuminated by concealed lighting behind the glass cills of the high windows. Each cill conceals three 60-watt and four 30-watt tubular lamps, with a total load of 3,000 watts.

The total loading of the hall is 14.36 kw., but on no occasion will more than 10 kw. be used, and, with lighting at ¾d. per unit it gives a running cost of 10.7d. per hour.

### The Reception Room.

This interior is used for Ceremonial and Exhibition purposes and is illuminated by four silver-bronze torchére fittings, two at each end of the room. With specially designed reflectors the light is well distributed over the interior, and provision was made in the design of the torchére to take either 300-watt lamps or 500 watts. At present 300-watt lamps are used, giving an illumination of 3 foot-candles.

### The Committee Rooms.

This Committee Room is illuminated by four pendant fittings, each containing a 200-watt pearl lamp. The walls are lined with leather, a material rarely used in decoration; its colour of light fawn provides a good reflecting surface. The ceiling is of acoustic material which leaves the ceiling surface slightly uneven. The lighting arrangement, however, illuminates these imperfections, owing to the diffusion of the light. The room is 584 sq. ft., with 800 watts for the illumination and with approximately 1.47 watts per sq. ft. The intensity is 7.75 foot-candles.

The portrait of Sir Aston Webb is lit by a concealed spot-light.

The smaller committee rooms, with an area of 338 sq. ft. are illuminated by floor torchères with a 150-watt lamp in each.

### The Library.

The Main Library is illuminated by concealed reflectors in the rounded ends of the bookcases, using the ceiling as a general reflecting surface.

Several schemes were discussed for providing striplighting on each range of shelves, but were discarded for the present scheme on the grounds of better appearance, simplicity, less lamp replacements, easy maintenance, and, most important of all, a form of lighting ideal for reading purposes.

In the calculations, preference was given to the illumination on the vertical surface of the stacks, as it was known that the illumination on the horizontal surface would be adequate for all purposes. An average intensity of 3 foot-candles on the vertical surface was the aim, with a result that the horizontal surface provided an intensity of 7½ to 8½ foot-candles.

In the design of the reflectors care was taken to provide flexibility, so that in the future, should it be required to increase the illumination, this could be done. At present 300-watt lamps are used in each stack, and may be increased to 500 watts if required

The total area of the library, excluding the upper galleries, is 2,868 sq. ft., with a total load of 3,000 watts, or 1.04 watts per sq. ft.

Provision for table lights has been made, should it serve a useful purpose in the future.

### The Henry Jarvis Memorial Hall.

Each of the troughs below the windows in this room contains three 150-watt reflectors concealed from view, providing an average intensity of 3.2

Figure 2. A detail of the lower ceiling of the Henry Florence Memorial Hall shows the disposition of the Saucer dome fittings. The lighting is arranged to catch the edge of the sculptured panels.

Figure 3. The lighting of the main staircase is from pressed glass panels in plaster coffers. Access is from traps in the library floor. Each of the panels is well set up in the coffers, so as to make them less conspicuous when at second floor level.

foot-candles, the total load of 2,700 watts. The area of the room is 2,537 sq. ft., and the consumption 1.4 watts per sq. ft.

### The Foyer.

Various schemes were considered, e.g., the concealing of the lighting in the ceiling and the use of suspended fittings. In each case the question of access became impractical. The final system involved the use of two silver-bronze torchères with 500-watt lamps in each, projecting their light from one end only; a method of lighting which has hitherto been little used, but opens up great possibilities architecturally.

Over the foundation-stone and the Past President's portrait five panels, each containing a 60-watt tubular lamp, provide illumination to this recess only, and, during the times when this portion of the building is not in use, is the only illumination in the interior, which may be seen through the small window when mounting the Main Staircase.

### Clerk's Office.

This room, with an area of 1,377 sq. ft., is lighted by 14 opalized spheres, each containing a 150-watt lamp, a total load of 2,100 watts. The average illumination is 7 foot-candles or 1.44 watts per sq. ft.

### The Cloaks Hall.

Owing to the low ceiling height, flush circular glass panels were incorporated in the plaster ceiling. In each case a single silvered lamp was used, the light being reflected on to a secondary reflector. The multiplication of these units provides a diffused light over the interior. In each fitting one 60-watt lamp is used. The total load over an area of 1,180 sq. ft. is 720 watts.

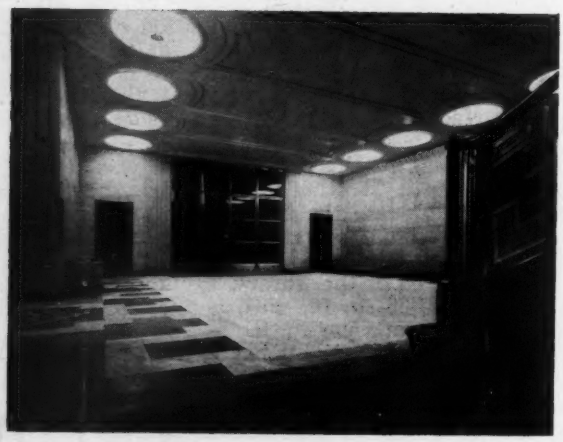


Figure 4. A general view of the Entrance Hall illustrates the effect of illuminating the walls of an interior which in certain cases has a definite advantage.

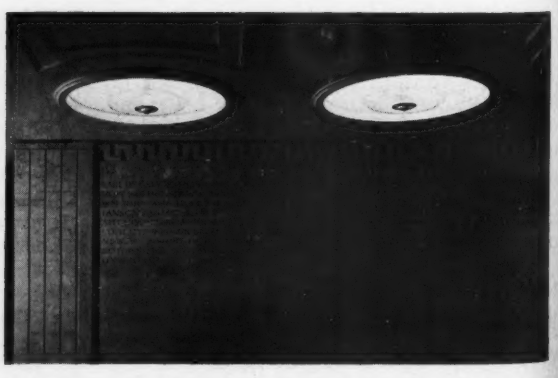


Figure 5. A detail of the Entrance Hall fittings are similar to those in the Henry Florence Memorial Hall. Each contains a 60-watt lamp.

# Some Properties of Cells used in Holophane-Edgcumbe Autophotometers

By S. ENGLISH, D.Sc., F.I.C., F.Inst.P.

Rather more than twelve months ago the question of the use of photo-electric cells for measuring illumination cropped up in the discussion of a paper, and in his reply to the discussion, the author remarked that photo-electric cells were good when used very cautiously, but they were apt to "lie without blushing." For this reason the present author, on the basis of several years' experience, though finding such cells (both vacuum and rectifier types) most useful in a research laboratory, recognised that the early types were not quite all that could be desired for building into instruments for general use. On the one hand, vacuum photo-electric cells of the valve type, though quite good as regards the linearity of response to light, had not a spectral sensitivity closely approaching that of the human eye, and furthermore, they required external batteries to produce an internal potential difference. For these reasons their usefulness in photometry appeared to be limited to the laboratory. On the other hand, the rectifier type of cell requires no external batteries, and is, therefore, from this point of view, more suitable for building up into portable photometers and instruments for general use.

However, before such an instrument could be put out with confidence by anyone who knew anything about portable photometers and photometry in general, the lying propensities of these cells, already referred to, had to be overcome. This has been done by removing those predisposing conditions that encouraged untruthfulness, by attending to the following details.

### Spectral Sensitivity.

The earliest cells of the rectifier type had a pronounced maximum sensitivity in the extreme red or infra red portion of the spectrum, and an almost complete insensitivity to green and blue light, so much so, that they seemed nearly as sensitive to the glow of a lighted cigarette as to a small wattage electric lamp. The newer cells are infinitely better in this respect, since they show a maximum sensitivity in the yellow region of the spectrum and a smooth falling off on each side of this maximum, giving a complete sensitivity curve not very far removed from that of the human eye (see this journal, Feb., 1935, p. 48). As a result of this similarity an instrument embodying one of the best of the modern cells used with ordinary gas or electric lamps, gives readings of illumination very close to readings taken on a visual photometer. If, however, the instrument is calibrated for use with gas and ordinary electric lamp light, a correction needs to be applied to the readings when it is used with daylight, or with light given by sodium and mercury discharge lamps. (See Table 1.)

TABLE 1.

Comparison of Visual (Lumeter) readings and Autophotometer indications with various Light Sources.

| LIGHT SOURCE | Lumeter (Average) | Autophotometer | FACTOR: Lumeter / Autophotometer |
|---|---|---|---|
| Electric Lamps. | | | |
| G.E. 100-w. | 6.1 f.c. | 6.1 f.c. | 1.00 |
| „ 300-w. | 16.2 „ | 17.0 „ | 0.96 |
| Vac. 40-w. | 1.65 „ | 1.6 „ | 1.03 |
| Incandescent gas | 9.8 „ | 9.5 „ | 1.03 |
| Daylight (dull grey sky) | 25.5 „ | 21.0 „ | 1.21 |
| Sodium lamp | 7.3 „ | 5.8 „ | 1.25 |
| Mercury lamp | 29.7 „ | 23 „ | 1.30 |

In using Autophotometers which are designed for general use, it is sufficient to have factors for daylight, sodium, and mercury lamp light, and apply such factors whenever they happen to be required, but in the Autophotometer specially designed for street lighting measurements, and which may, therefore, be expected to be suitable for use with discharge lamps, these factors have been replaced by a switch on the instrument panel. This switch is so arranged that by turning it to the appropriate position the foot-candle readings of the instrument are automatically corrected for whichever form of illuminant is being used.

### Linearity of Response.

It is not essential in simple photo-electric photometers that the response should be proportional to the light incident on the cell, for any lack of proportionality can be overcome in the calibration of the instrument and in the fitting of a suitable scale. It is, however, an advantage to have cells whose response is proportional to the incident light since it simplifies calibration and scaling, and in multirange instruments it is almost essential to have such cells so as to avoid a confusion of lines in the various scales. The linearity of response of the cells used in Autophotometers is indicated in Fig. 1, which shows the results of illumination readings taken on two different cells when lamps are placed at increasing distances from the cell surfaces. The readings are plotted against the reciprocal of the square of the distance between the cell and the source, and the fact that the points fall on straight lines shows the linearity of response of the cells.

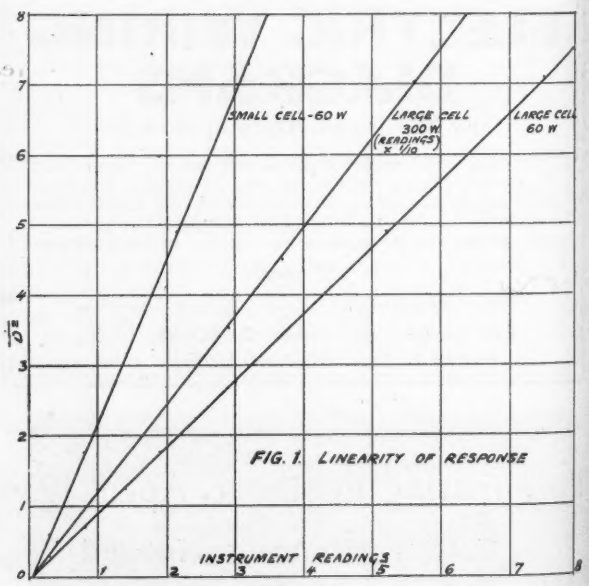



Figure 1.

### Variation from the Cosine Law.

One of the chief weaknesses of early forms of rectifier-photo-electric cell photometers, was that if they were calibrated to read correctly when the light was incident along the normal, their indications were very much too low when the light was incident at wide angles from the normal. Consequently, they could not be used with any degree of confidence when measuring diffused light, such as for example, day-

light or room lighting from indirect fittings, nor could they be used satisfactorily for street lighting measurements where the most important measurements are those which involve the use of very oblique incidence. In this particular case the difficulties due to oblique incidence can be overcome by tilting the sensitive surface until it is normal to the incident rays and then calculating back to horizontal illumination, but unless special precautions are taken to avoid powerful road surface reflections reaching the cell surface, this method is liable to give very misleading results. (This argument also applies to visual street lighting photometry).

In order to reduce the departure from the cosine law to an absolute minimum, tests on numerous possible methods were carried out. These tests involved the setting up of the particular cell under test on a turn-table so that a strong and uniform beam of light fell on it. On rotation, the response could be read for light incident at all angles from the normal to grazing incidence. Some of the surfaces tested included (a) the normal lacquer finish, (b) lightly frosted cover glass, smooth side outwards, (c) coarse

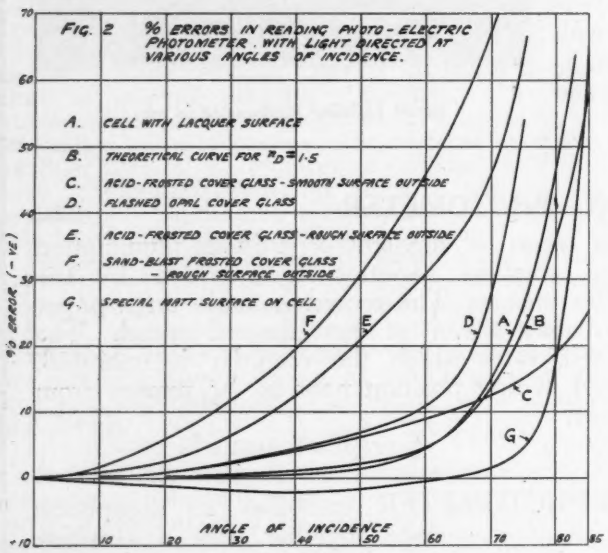



Figure 2.

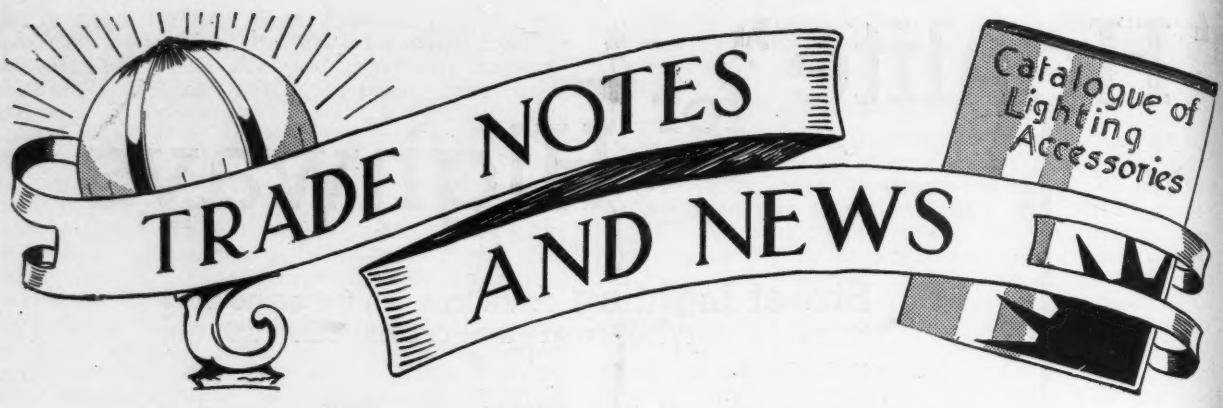
sand-blasted cover glass with the rough side outwards and inner surface cemented with colourless transparent cement to the cell surface, (d) flashed opal cover glass cemented as (c), (e) pot opal cover glass cemented as (c), (f) special matt surface produced on the cell itself The percentage errors in the actual readings at each angle of incidence, for each of the above tests are given in the form of curves in Fig. 2, from which it is clear that anything in the nature of a dispersive cover glass is quite useless, and that the special matt finish used on Autophotometer cell surfaces is the only means yet tried that makes it possible to use such cells with confidence for both general and street lighting measurements.

### Creep and Temperature Coefficient.

In some quarters it is supposed that photo-voltaic cells have a tendency to get "tired." If they are maltreated it is not to be wondered that their action responds to such treatment, but if used with reason and if the component parts of the instrument are well balanced, the best cells are to-day quite satisfactory in this respect. In an attempt to see how far maltreatment caused a reduction in its readings, an instrument made about twelve months ago was placed only two feet below a 300-watt lamp and left there for one hour. The readings fell from 70 to 68, a drop of nearly 3 per cent. A slightly different instrument (Model B Autophotometer) made more recently was tested similarly, but not quite so drastically. A 200-watt lamp was used and left in operation for an hour and a half. The readings only fell from 62.5 foot-candles to 62.3 foot-candles, an absolutely negligible variation. Of course, it may be argued that this refusal to "tire" may be only apparent, and that the constancy of the reading was in some way due to a balancing effect in which a temperature coefficient played a part. To check this point, an attempt was made in the above test to maintain the cell at a uniform temperature, by enclosing it in an open top box with a forced air circulation. Immediately after the conclusion of the creep test, the air circulation was stopped and the box containing the sensitive cell near its base was warmed up (it being mounted on an electric "hot plate"). Readings were taken at one minute intervals over a period of ten minutes, during which time the temperature of the air adjacent to the cell rose as high as 28°C. The readings throughout the whole period were surprisingly constant, and in no case did the variation from the initial reading exceed 0.3 per cent., or 0.05 per cent. per degree Centigrade. This freedom from temperature coefficient is of course a very great advantage in a street lighting photometer, as all who have experience of this type of work know that arrangements for street lighting measurements seem to synchronise with outside temperatures which are very much lower than the warm atmosphere of the laboratory in which the instrument was calibrated.

## Floodlighting Snowdon

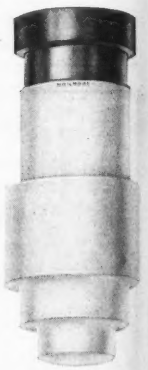
A spectacular present to Sir Michael Duff Assheton-Smith, on the occasion of his marriage last month, was the floodlighting of the summit of Snowdon by the North Wales Power Co. Bonfires also blazed on the surrounding hills. To those who recall ascents of Snowdon via the P.Y.G. track or the Crib Goch Ridge, in blinding rain and snow, the floodlighting of its summit is indeed a novelty!



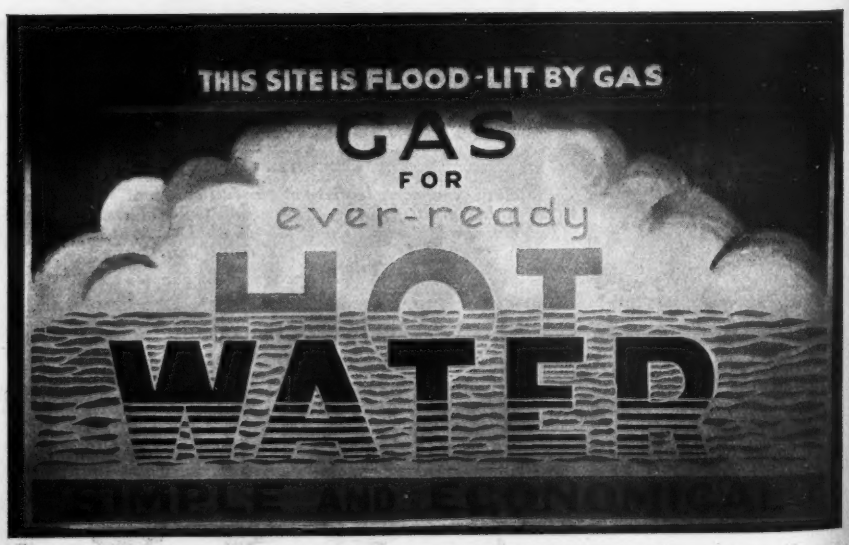

# Jubilee Celebrations

**Some Attractive and Novel Hailware Products.**

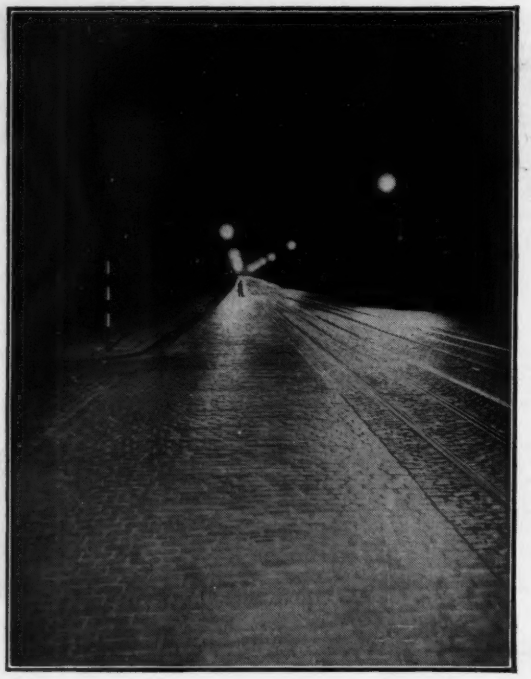
From now onwards increasing interest will be taken in the Jubilee celebrations in May. Next month we shall be referring more fully to the part which lighting will play therein. For the moment readers may be advised to take note of the enterprise shown by leading firms in the lighting industry, who are preparing special designs for the occasion. The accompanying illustrations, for instance, feature several attractive designs of decorated globes made up by Hailwood and Ackroyd, Ltd. These are intended primarily for exterior lighting, e.g., for use on street lamps, newel posts or outdoor signs. They are executed in pleasing colours, and present an attractive appearance both by day and by night. These designs are British-made throughout, the complete manufacturing processes being carried out at the firm's factory at Morley (near Leeds).




Mr. Bloor's recent paper showed the opportunities for floodlighting by gas, from the aesthetic aspect. There is another field where it can be effectively used—for the lighting of posters and hoardings, where, as a rule, no very concentrated beam is needed. The adjacent picture shows one of several railway station poster sites, for each of which two 9-light lamps were used.




**A Striking Railway Station Poster, floodlighted by Gas, which has been installed in Liverpool.**



Camden Road, St. Pancras, lighted by Mazda Mercra Lamps in B.T.H. "Diron" Lanterns.
(Note: The pedestrian in the distance is approximately 100 yards from the camera, which gives the reader a good idea of the visibility afforded.)

The illustration shows part of the North Circular Road, Willesden, lighted by Mazda Mercra Lamps in B.T.H. Mercra "H" Lanterns.

## Two Examples of Street Lighting with Electric Discharge Lamps

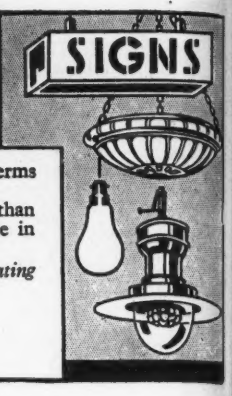
**The proprietor of British Patent No. 268293, dated March 25, 1926, relating to "Automatic Cut-Off Valve" is desirous of entering into arrangements by way of a licence or otherwise on reasonable terms for the purpose of exploiting the above patent and ensuring its practical working in Great Britain. Inquiries to B. Singer, Steger Building, Chicago, Illinois.**

## Strand Electric Contracts

The well-known theatre lighting specialists, Messrs. The Strand Electric and Engineering Co., Ltd., have recently completed important stage lighting at the A.D.C. Theatre, Cambridge. Other work in hand includes the Ritz Cinema, Southend, where their battens, footlights and stage switchboard will form part of the engineering equipment. Citizen House, Bath, is another important factor in theatrical circles, where deep interest is taken in dramatic production. Here the Strand Electric Company are making a special effort in regard to tri-colour cyclorama lighting. Other contracts include Dreamland, Margate; Empire, Kingston; Theatre Royal, Newcastle; and Majestic, Rochester.

Readers are doubtless aware that the same company was recently responsible for highly interesting improvements in the stage lighting at Covent Garden Opera House, reference to which was made in this journal some months ago (Illum. Eng., June, 1934, p. 200).

# ·WHERE TO BUY·
## A DIRECTORY OF LIGHTING EQUIPMENT

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